EDITORIAL

HIGH praise is due to the broadcasting industry for its virile answer to the challenge of TV during 1959.

There was a time when we might have been excused for wondering whether broadcasting executives were being realistic in their view of the future.

Figures were quoted and assurances given about the continued prosperity of radio overseas where TV competition already existed. The inference was that the same thing would happen here, that there was no need for dismay.

But, in fact, the kind of radio to which those figures referred had already absorbed the impact of TV, and had geared itself to meet it.

A similar and essential process was required in Australia before a fair comparison could be made, and many broadcasting people were not looking forward to it.

Today there are big differences in programming, enterprise, and planning.

They have been carried out individually, and on an organised basis under the guidance of able administrators.

These men have realised that there has been and will continue to be an inevitable change in the entertainment scene, and that their future lies in meeting it with courage and competence.

Broadcasting today is concentrating on those fields which TV finds impracticable and unprofitable to pursue. For instance, it remembers that a vast number of receivers sold at present are portables and car radios, while it realises that growing numbers will be lost to increasingly attractive shows TV will stage in the evening hours.

It has even been enterprising enough to use stereo, the latest and most intriguing star in its future.

There must not be any let-up in 1959 or in the years after that.

TV will have its own problems, but so far it has only gained a foothold. The process will continue, and it won't make the re-orientation of radio any easier.

But the total radio and TV audience is increasing all the time, and TV's gain need not necessarily be entirely at the expense of radio.

There is a big market yet to be exploited and sold.

The audience waiting for both is expanding in step with the country's growth, and there will be ample opportunity for each to render its own proper and profitable service.

John Moyle

INDEX

	Page
Atlas Takes Off Into Space	3
Inside The Atlas Blockhouse	4
Design For Living On Moon	11
Will We Dig With A-Bombs?	13
The Source Of The Earth's Magnetism	16
Solid State Panel Amplifies X-Ray Image	21
Unique PA System At Brussels	27
News and Views of the Month	49
Amplifier Response & Stability Part 2	32
From The Serviceman Who Tells	43
Extra Performance From One Transistor	48
Further Notes On R-C Bridge	55
A Course In Television	57
Here's Your Answer, Tom	62
Improvements To The Simple VTVM	65
A Clip-on DC Milliammeter	71
More About Amplifiers For Churches, etc.	75
Taking Photographs Of CRO Patterns	80
Trade Reviews And Releases	91
New Books	95
Let's Buy An Argument	96
Off The Record—News and Reviews	102
Short Wave Notes	112
The Amateur Bands	113
Answers To Correspondents	125

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OUR COVER PICTURE

"Bluebird," Donald Campbell's speedboat which recently set a new record of almost 250 m.p.h. is rarely photographed out of the water. Here the unusual design is revealed. It stands outside Campbell's workshop.

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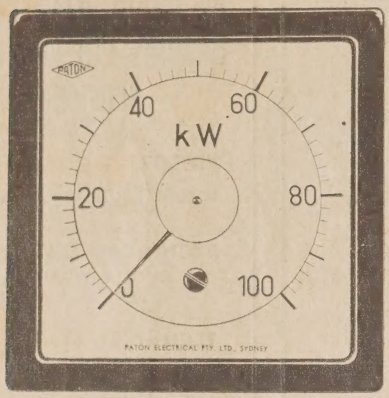

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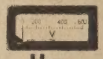
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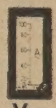
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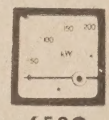
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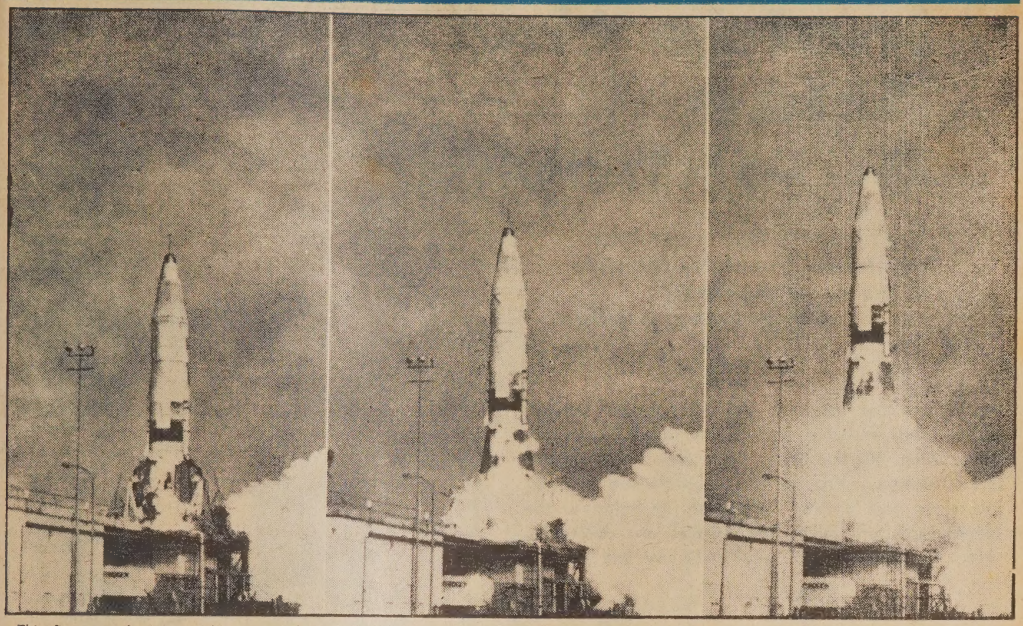
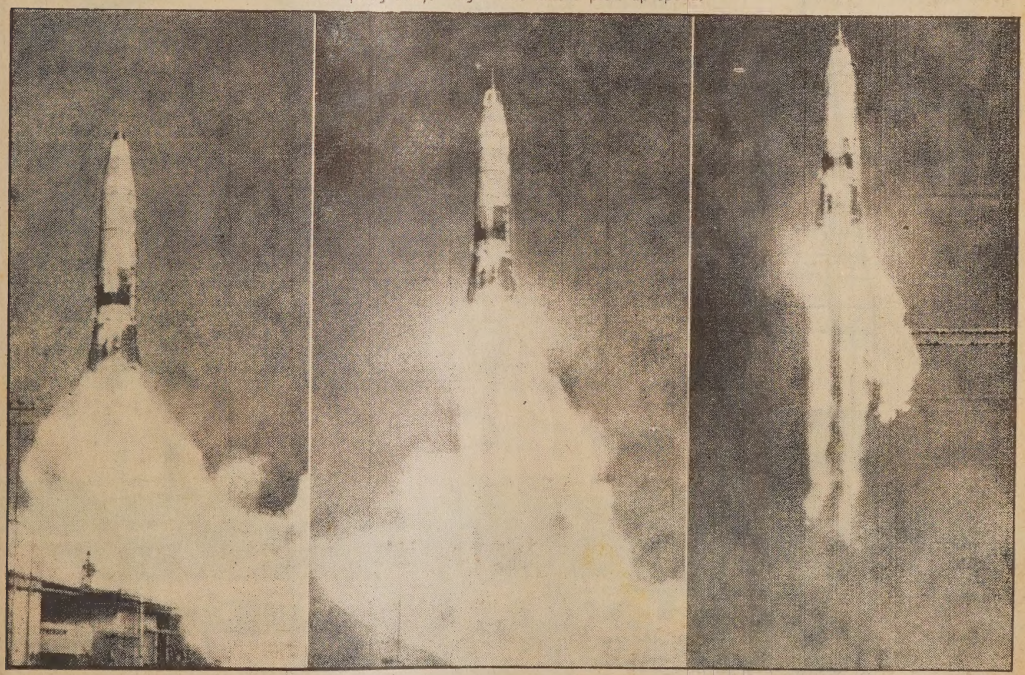
ATLAS TAKES OFF INTO SPACE



This fine set of pictures shows an Atlas missile blasting off at Cape Canaveral. Left—the engines are fired. Centre—the support arms spring away. Right—the missile picks up speed.



Left—the twin jets become visible as Atlas clears its wake of smoke. Centre — the missile soars skywards as the pad burns. Right—Atlas is well launched and on its way.

Inside the Atlas Blockhouse

The concrete fortresses from which they launch the missiles of the Space Age are as impregnable as man can build

The success and failure of the Atlas guided missiles has focused intensive interest on Cape Canaveral from which all the firing tests have been made. Great secrecy surrounds the project, and recently journalists were allowed to inspect the inside of the blockhouse from which the missiles are controlled. Here is an account of what they saw and heard.

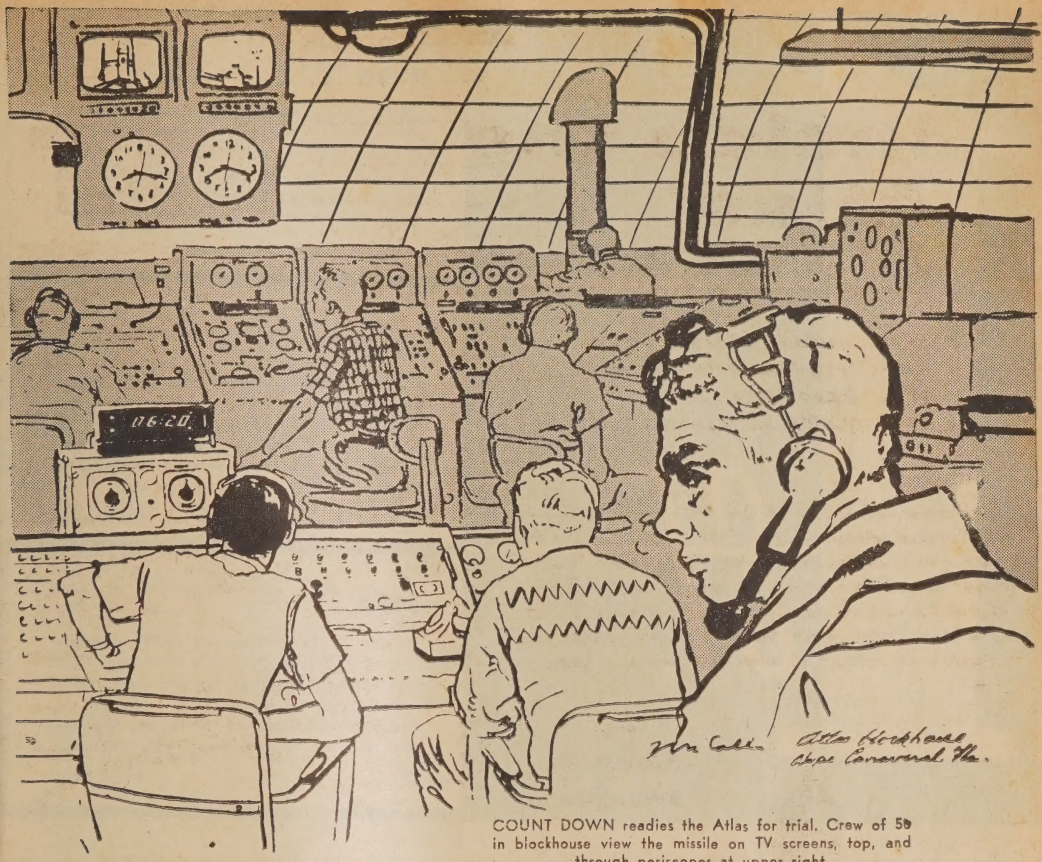
By Alden P. Armagnac

STRANGE fortifications have risen from the palmetto-dotted sands of Cape Canaveral in Florida. The smaller ones, squat concrete blocks with windowed slits, call to mind the bastions of a Maginot or Siegfried Line. The biggest of the fortresses look like gigantic anthills—huge windowless cones of sand-covered concrete, some 160ft in diameter at the base. Atop them, rows of periscopes lift metal flaps like eyelids, and peer out upon sand and sea.

What mysterious purpose these installations serve would tantalise a pre-Space Age military-intelligence officer. Could they be, he might ask himself, for some futuristic form of coast defence? The truth is stranger; they are for defence against no invading enemy, but from our own weapons.

These are the blockhouses from which, by remote control, they launch early trial versions of our great ballistic missiles and satellite-bearing space vehicles. Anything can happen in the perilous initial tests of giant rockets, crammed with explosive fuels and searing acids. And that explains these massive bunkers.

At its Cape Canaveral launching site, the Air Force Missile Test Centre conducts trials for all the armed services. The destructive might of each type of missile, should it explode on the launching pad, is reflected in the size and staunchness of its blockhouse. The smaller ones fire Vanguard, Thor, Jupiter; the great



COUNT DOWN readies the Atlas for trial. Crew of 5 in blockhouse view the missile on TV screens, top, and through periscopes at upper right.

anthills-with-periscopes, the Atlas intercontinental ballistic missile.

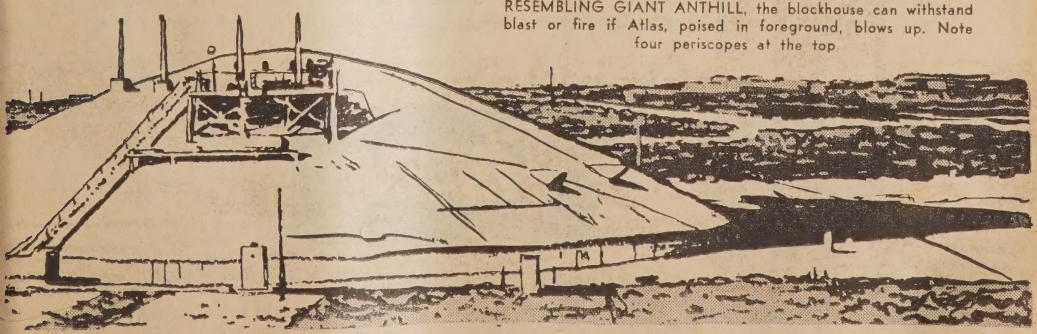
A black, white and silver Atlas, due to be fired within the next few days, already stands cradled in its 12-storey-high servicing gantry at Pad No. 12, where an Air Force bus drops you off. It towers more than 80ft high, and looks to be at least 12ft in diameter.

You've seen the Atlas in pictures before but only now, standing near it, do you realise how big it is. The "pad" it rests upon is a steel-and-concrete launching platform, at the end of an inclined ramp. This is one of four Atlas launching sites, each with its own blockhouse, at the Cape.

The great low blockhouse, its sandy, light tan coat like the Cape sand underfoot, stands less than 10 missile-lengths away. Its walls are 6 to 10ft thick, and its dome of steel-reinforced concrete is topped by a 10ft layer of sand.

Designed to withstand the explosion of 50,000lb of TNT 50ft away, it offers protection against blast, fire, flying wreckage—anything but a direct hit by the Atlas itself. A tunnel-like entrance leads you to the single doorway, closed and sealed at firing time by a steel door 8in thick, and you enter the blockhouse's interior.

You find yourself in a circular room 115ft across, illuminated by ribbonlike panels of light along the ceiling. Gazing at its panoply of electronic consoles, instrument dials, and twinkling indicator lights, you could imagine



RESEMBLING GIANT ANTHILL, the blockhouse can withstand blast or fire if Atlas, poised in foreground, blows up. Note four periscopes at the top

1ST.

1956

Thomas was the first Company to produce a 21-inch picture tube in Australia. It was a 90-degree aluminised tube with electrostatic focus, incorporating a "bent" gun and ion trap. Public acceptance of the larger picture soon established 21-inch tubes as the most preferred size in all makes of receivers.

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yourself in the control cabin of a spaceship of the future.

On four television screens at the front of the great room, you see the very scene you have just left—the Atlas and its gantry, at the launching pad 750ft away. The screens show the missile from four viewpoints, 90 degrees apart. At will, each image can be varied from a distant view to a close-up one.

Four periscopes, along the wall at the front and to the right, enable observers to view the missile directly. The periscopes' shafts disappear into the room's ceiling, to rise like masts above the top of the blockhouse.

Clock faces, just below the TV screens, guide a countdown's timing. One dial shows standard time. A second one registers time elapsed from the beginning of a countdown. A third and fourth show total and individual duration of "holds," the unscheduled interruptions of the countdown to remedy any difficulties that may arise. At a number of key points in the room, there also are digital counters whose glowing red numerals show the remaining minutes and seconds to firing time.

BLOCKHOUSE CREW

A blockhouse crew of 50 technicians mans this array of equipment for an Atlas launching. Over them presides the test conductor, civilian from the Convair company that makes the Atlas, who sits with his assistant at a central console.

Any visiting VIPs get shooed into a glassed-in observation booth at the rear, complete with its own TV sets, where they'll be out of the way. Nobody else, but nobody, gets in during a launching.

That's the setting for the countdown that precedes an Atlas firing—a meticulous checkout of missile components and launching facilities for readiness, comprising as many as 4,000 items and taking four hours or more to complete.

Of course, that doesn't mean it would take hours to fire an Atlas, when it's in service. The thing to remember is that this isn't an "operational" firing at all, but a proving-ground trial.

Tracking cameras, radar installations, telemetering stations, successively springing into action at the Cape and all along the ocean firing range, will gather an immense variety of performance data. When such trials have perfected the Atlas, perhaps by next year's end, the Cape will be through with it. Then it will go to operational I.C.B.M. bases at Cheyenne, Wyoming, and other U.S. sites still to be announced.

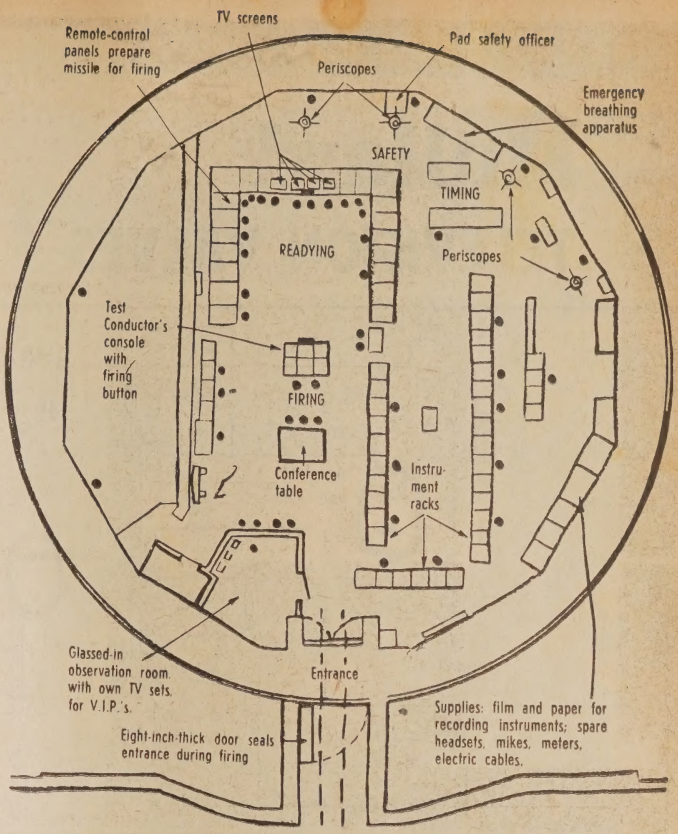
LAUNCHING ACTIVITY

Launching activity at the pad begins well before the countdown. Within the blockhouse, circuits are tested, needed supplies assembled and checked. Emergency oxygen apparatus is made ready. If a missile catastrophe should envelop the blockhouse in flames or noxious fumes, this equipment will provide a 30-to-40-minute air supply to breathe.

Usually between 3 a.m. and 7 a.m., the countdown starts. Out at the pad, which for some time is the centre of activity, steel-helmeted missilemen load the Atlas with fuel. They install an explosive "destruct" charge to enable the missile to be blown up by radio control, if it should fly erratically and become a menace. Signal lights, at the pad and at the blockhouse's entrance, change from green to amber as the Atlas becomes "hot" or dangerous.

Overhead, two planes roar out to sea. By radar, one searches the danger zone for ships; the other monitors the ether for radio interference in the channels to be used in the Atlas trial.

Its work done, the 125ft high, red-and-white gantry ponderously rolls away from the pad, leaving the Atlas poised for flight—the angle-of-attack indicator at its nose suggesting a spear about to stab the sky. The signal lights change from amber to red—clear the pad, take cover. Behind the last man into the blockhouse, the steel door clangs shut.



CIRCULAR ROOM in blockhouse, 115 feet across, contains remote-control equipment, as shown, for launching Atlas. Black dots indicate stations of men who operate maze of apparatus.

MANNING STATIONS in blockhouse, technicians check on some 4,000 items during countdown.

Now all are at their stations in the blockhouse's great circular room, at panel with such labels as ENGINE TEST, TELEMETER, MISSILE POWER, LOX TANKING INTERIM. At "T minus 35"—35 minutes to firing—ultra-hazardous liquid oxygen is pumped into the Atlas lox tank by remote control. Instruments check the missile's weight, the level of lox, the tanks' pressure. With 10 minutes to go, the blockhouse counter begins calling off each passing minute.

T MINUS TWO

"T minus two"—and the blockhouse's ventilating blowers whine to a stop, as intakes are sealed for safety. Things are happening fast now. Missile circuits are switched from outside power to the Atlas' own. A gyro is uncaged. Panel operators, queried in turn by the test conductor over the intercom, confirm completion of final steps.

At Central Control, the firing range's nerve centre in a green-tinted building three miles away, the planes' reports are in: no ships in the way, no radio interference. Downrange observing stations are alerted and ready. Clearance to fire

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6R3
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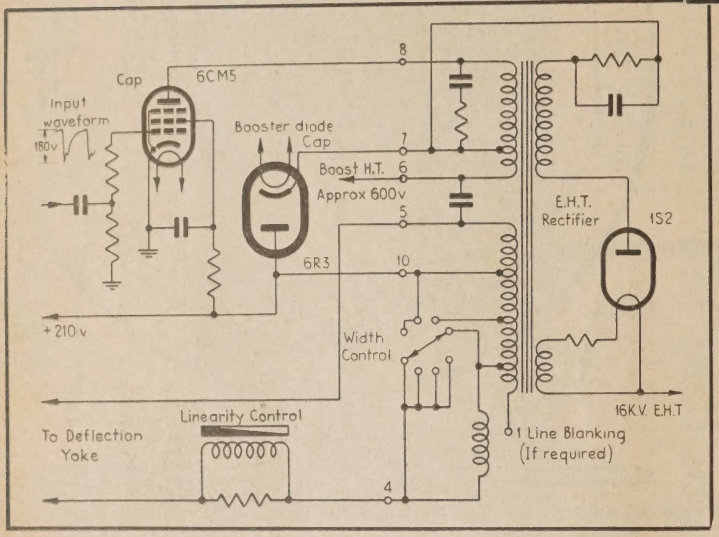

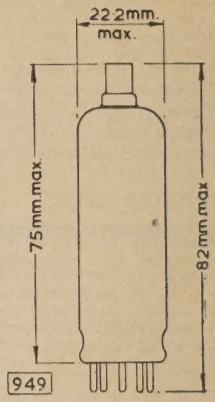

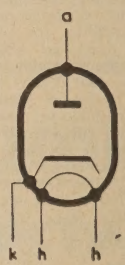

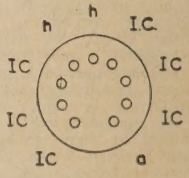

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Anode Current Peak	275mA	260mA
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passes from Central Control to the blockhouse.

A dozen indicator lights glow green on the console of the man who fires Atlas—all is ready. The time is T minus 30 seconds . . . 25 . . . 20 . . . The test conductor presses a little black button marked VERNIER START.

That does it. "Automatic sequencing" takes over. Cameras begin whirring oscillographs recording. At T minus five seconds, flame spurts from vernier rockets on the Atlas' sides—two small auxiliary engines that help to stablise flight and control final speed. A Niagara of cooling water, 30,000 gallons a minute of it, cascades down the flame detector beneath the Atlas.

MAIN ENGINES FIRE

Even within the sealed and massive blockhouse, the crew hear the thunder and feel the floor quiver, as the Atlas' main engines erupt an inferno of fire. They turn the cooling water to billowing clouds of steam, rising and enveloping the Atlas. For 10 seconds the great missile strains against rugged hold-down arms—an innovation pioneered by Atlas —as it builds up thrust.

Up to that last moment, the launching could still be halted, if something should go haywire and one of the tense instrument watchers should call out "Cutoff!" Just to the right of his black firing button, the test conductor has a similar red one, marked VERNIER CUTOFF. Pressed before the main engines start, it will override the sequencer and stop the launching. If it's too late for that, the test conductor would smack an adjoining red knob labelled MAIN ENGINE CUTOFF.

But this time, there's no hitch and the red controls go untouched. At T plus 10 seconds, the hold-down arms spring away from the captive Atlas and free it.

Slowly and majestically at first, then with mounting velocity, the thundering Atlas rides its twin blowtorch columns skyward. Its shrinking image vanishes from the blockhouse's TV screens, whose tilting cameras have followed it upward. The blockhouse's launching task is done.

TRACKING THE COURSE

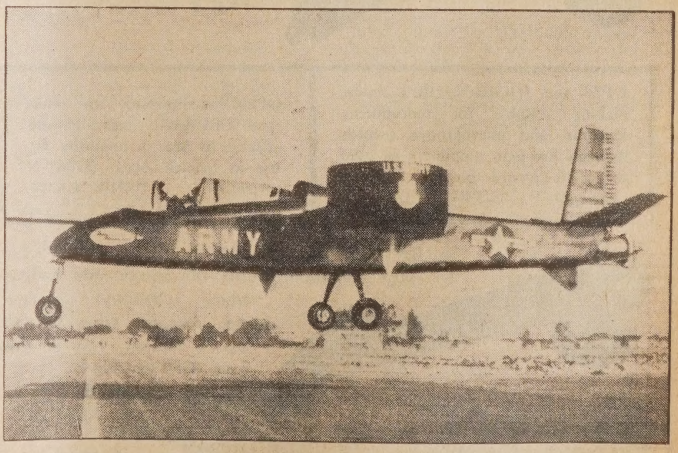
The fate of the speeding Atlas hangs now upon the Range Safety Officer at Central Control, where tracking equipment is charting the missile's course with incredible speed and accuracy. If its path wanders beyond predetermined safety limits, he must press a button that destroys the two-million-dollar missile in mid-flight. That has happened; but there have also been more successful shoots, of trial Atlas missiles that escaped his intervention.

And from each of the Atlases that have completed their flights, priceless stacks of recovered data are speeding the day when our I.C.B.M.s will be perfected.

So it can be said that, by fulfilling their hazardous task of launching these trial missiles, the men in the Cape Canaveral fortifications are helping to fortify the whole nation.

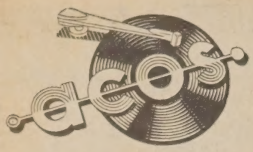
A BALLOON FOR SPACE TRAVEL

A 12ft aluminium plastic balloon scheduled to rocket into space by a Jupiter C. It will be in a 7ft artillery shell type case 7in in diameter. At a given altitude the balloon will be ejected, inflated with nitrogen and go into orbit.



LATEST IN VERTICAL TAKE-OFF—The new Doak 16 VTOL (Vertical Take-off and Land) aircraft as it hovers over the Torrence Municipal Airport. The ducted propellers on the wing tips give vertical lift, then rotate forward in transition and fly horizontally.

offering you the widest range of pick-ups . . .



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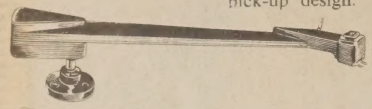

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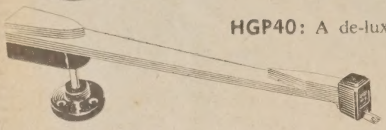

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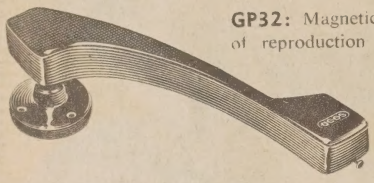

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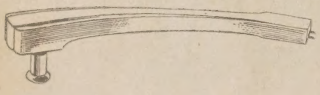

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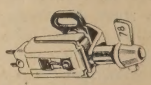
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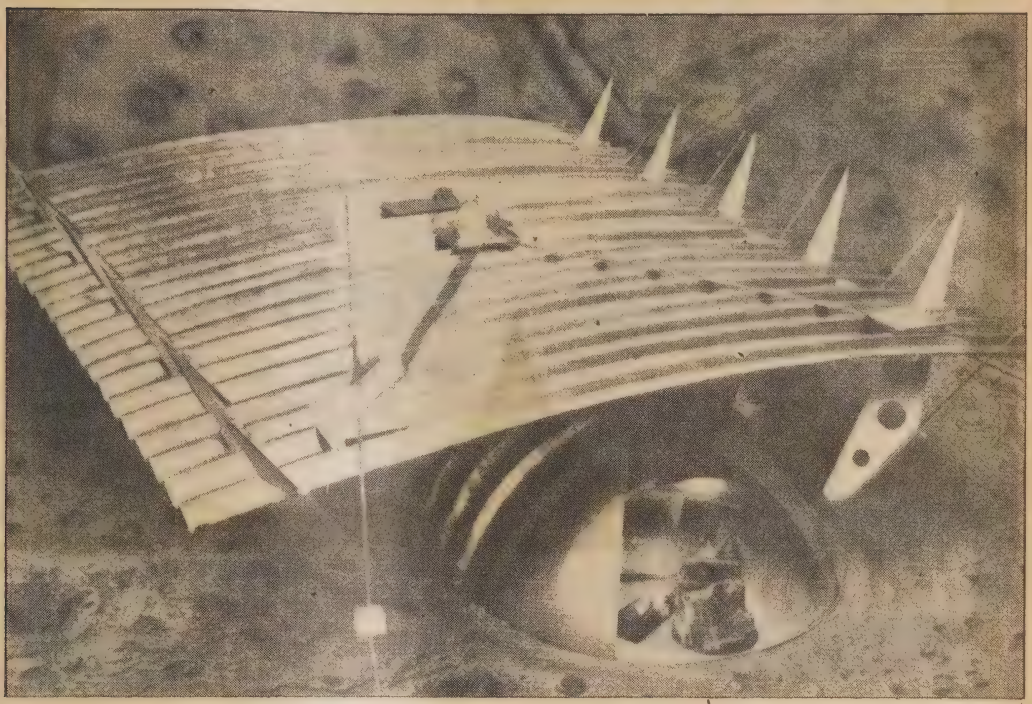


Scale model of moon building suggested as permanent living quarters for moon explorers. It has laboratories, workshops, radio rooms, etc. Upper section is a meteorite shield.

CLOSED CIRCUIT TV FOR NAUTILUS

Closed-circuit television equipment, so sensitive that it can "see" in the dark, was used on the submarine Nautilus for its recent trip under the polar ice pack.

COMMANDER William R. Anderson and his crew had a "seal's eye" view of the ice pack on a 21in monitor that warned them when the ship was too close to the bottom of the ice.

Engineers from the Mare Island Naval Shipyard and General Electrie's Closed-Circuit Television Operation installed the television system aboard the Nautilus at Pearl Harbour just prior to the sub's departure on its history-making voyage in July.

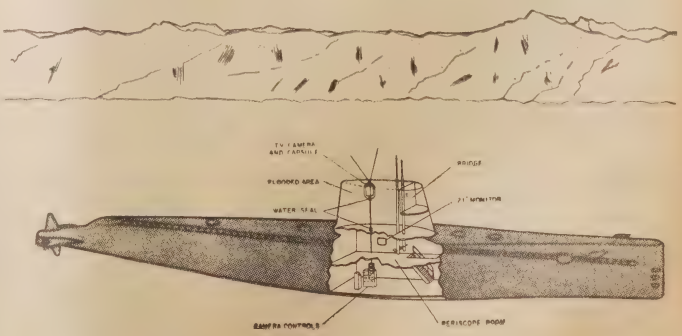
The camera was mounted vertically in a pressurised one ton steel capsule in the sail (conning tower) of the submarine. A glass porthole in the top of the capsule shielded the lens of the camera. A cable was strung through two watertight seals into the periscope room where the monitor showed a clear picture of the ice overhead.

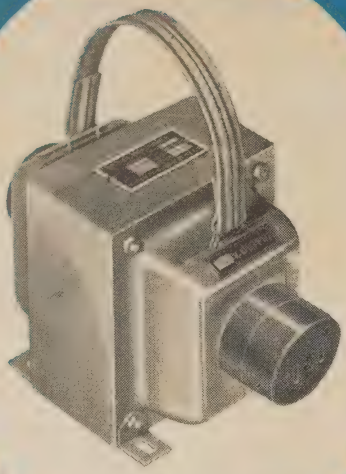
Once under the ice pack, Commander Anderson said that watching the ice on television, "was a fascinating sight. The ice looked like clouds passing overhead."

The camera needed no artificial light despite the fact that the submarine was below the ice pack and "very deep" according to Commander Anderson.

The television system complements the use of SONAR on the submarine. Installed SONAR is used to get soundings from objects above the submarine. These objects could do significant damage to the periscope if it were raised from its housed position.

Artist's sketch of TV circuit on Nautilus to detect pack ice.





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A110/60	240V 50 cycles	110V	60	3 3/4"	3 1/8"	3 7/8"	2 1/2"	2 1/8"	1
A110/100	240V 50 cycles	110V	100	3 3/4"	3 1/8"	4 1/2"	2 1/2"	2 3/4"	1
B110/175	240V 50 cycles	110V	175	4 1/4"	4 1/8"	4 5/8"	3 3/8"	2 3/8"	1
B110/250	240V 50 cycles	110V	250	4 1/4"	4 1/8"	5 1/4"	3 3/8"	3 "	1
C110/400	240V 50 cycles	110V	400	6 5/8"	5 1/4"	5 1/4"	3 1/4"	5 3/4"	2
C110/500	240V 50 cycles	110V	500	6 5/8"	5 1/4"	5 1/4"	3 1/4"	5 3/4"	2
C110/750	240V 50 cycles	110V	750	8 1/4"	6 1/4"	4 1/4"	4 1/2"	4 5/8"	2
C110/1000	240V 50 cycles	110V	1000	8 1/4"	6 1/2"	5 1/8"	4 1/2"	5 3/4"	2

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WILL WE DIG WITH A-BOMBS?

SCIENTISTS BLAST ROCK IN TESTS UNDERGROUND

Atom bombs for war will eventually give way to atom bombs for peace as we learn to use the huge explosive power to perform useful work. This article tells of some experiments being made to use A-bombs for earth moving, when a small one was exploded underground.

It may be possible to rejuvenate old oil fields, open up vast deposits of low-grade ores, and create huge underground water reservoirs for arid regions, all with atomic bombs.

That's the opinion of American scientists who are studying the results of deep underground atomic blasts that they touched off this year and last at their Nevada test site.

One of the explosions, the Rainer shot, was a "tiny" atom bomb only a tenth as powerful as the bomb dropped on Hiroshima, yet it crushed 500,000 tons of rock and broke up an additional 200,000 tons.

The intense heat of the explosion dissipated quite rapidly and yet three months later some of the rock still had a temperature of 190 degrees Fahrenheit, close to the boiling point of water.

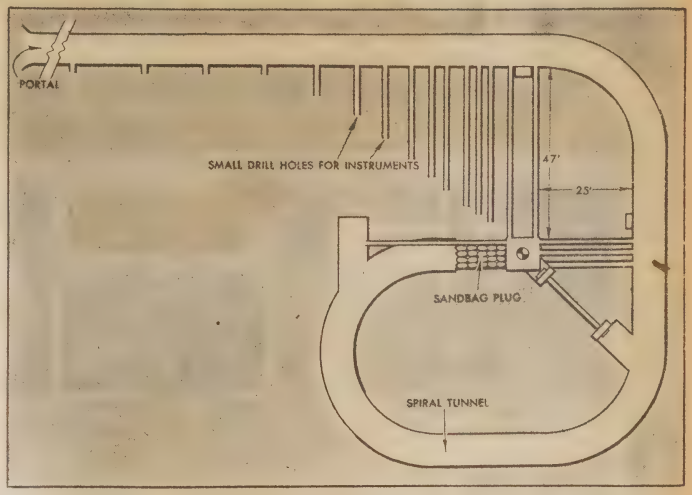
The bomb was exploded at the end of a tunnel 900ft below the surface of a mesa, in porous, water-saturated volcanic tuff. The tunnel was curved somewhat like a spiral so that it would be sealed by the blast, preventing any escape of radiation.

SURFACE EFFECTS

Spectators saw nothing but a ripple in the earth and numerous spurts of dust from dislodged rocks when the bomb was fired. Few of them felt any shock, though a slight tremor was recorded at scattered seismograph stations as far away as Alaska.

To study the effects of the bomb, the Atomic Energy Commission drilled exploratory holes from the surface of the mesa and from a point in the original tunnel. By examining the corings that were brought out by the drills the scientists were able to trace the story of what the explosion had done.

When the bomb went off, its terrific pressure pushed out the walls of the small chamber at the end of the tunnel and created a spherical cavity 110ft in diameter. The walls of the cavity were fused by the intense heat into a 4in-thick layer of black, glasslike material. The surrounding rock for a distance of 75ft was crushed almost into sand, then squeezed so hard that it became impermeable to water. Farther away, the rock was unchanged, though it "jumped" sufficiently to seal the access tunnel 200ft from the explosion point. The blast also shattered large amounts of rock in the tunnel as far as 400ft away.

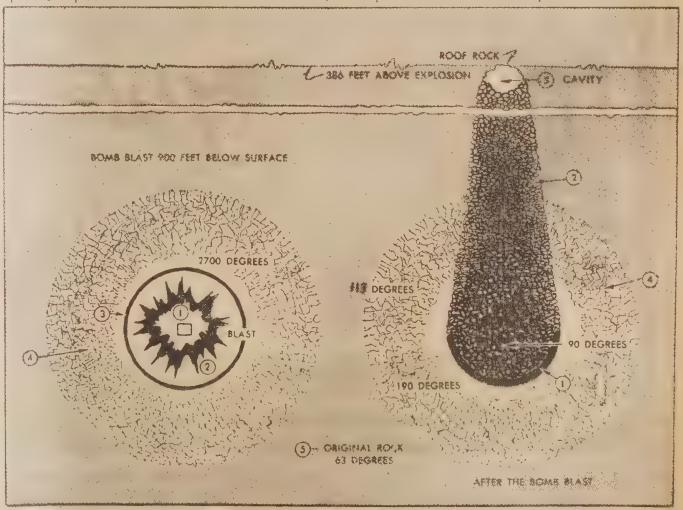


The diagram shows how a tunnel for underground atomic test was cut in spiral shape so it would be sealed off by the blast, trapping radio activity.

Almost immediately after the explosion the spherical cavity collapsed. The upper half of the glassy lining fell to the floor, and the unsupported rock above it caved in. Additional rock collapsed from above, then more rock. This continued until a strong rock layer 368ft above the explosion point was reached. In effect, a "chimney" of loose, unconsolidated material was produced.

Aside from a little radioactive gas in the chimney, virtually all radioactivity was confined to the mass of glass-like liner that lay in the lower portion of the original cavity.

Main purpose of the Rainer shot was to learn whether a nuclear weapon that was tested underground would eliminate the usual radioactive clouds, fallout, and flash and noise of an ordinary test. The experiment was a complete success. No



Drawing at left shows how blast in tunnel 1, made spherical cavity 2, with walls of fused glass-like rock 3, which trapped radiation. Surrounding rock 4, was crushed and compacted by pressure. Drawing at right shows collapse of cavity roof, after blast, leaving bowl 1 of fused material and 386ft high tower 2, of broken rock. Temperatures at right were taken three months after the explosion.

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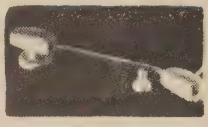

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radiation escaped to the atmosphere and there appears little chance that ground water could become contaminated.

In this test the underground rock cooled off quite rapidly because of its high water content. The heat turned the water into steam, which then escaped through pores and fissures. In relatively dry rock, temperatures of possibly 1,000 degrees might have persisted for months.

Scientists think that a much bigger bomb, exploded in dry rock, would create a great storehouse of heat which could then be tapped and converted into power.

Dr Willard F. Libby of the Atomic Energy Commission says that this may be done. The idea would be to pump water through the hot area, producing superheated steam that would be used to drive an electric generator. Some preliminary research on the idea is being done now.

IN OIL FIELDS

Another possibility is to use underground atomic blasts to recover more oil from depleted oil fields. Petroleum engineers say that no more than a third of the crude oil in an underground pool is extracted by pumping. Secondary recovery methods produce a little more, but possibly 50 per cent remains in the ground.

Still more should become available by an underground blast. The pressure created by the explosion would help free the oil trapped in relatively nonporous rock formations, and the heat of the blast would make the oil flow more freely.

The thought of creating underground water reservoirs is based on the expectation that a controlled blast could shatter immense quantities of rock underneath the run-off canyons of mountain ranges in arid areas. Rainwater from mountain storms would then percolate underground and be stored, instead of running off along surface channels and evaporating.

Dr Libby says that the cost of moving big quantities of earth and rock by atomic explosions is pretty low. He mentions the construction or improvement of harbours as one possible job for atomic bombs. There are still others. The creation of radioactive isotopes on a mass scale is one possibility, new and useful chemicals from nuclear explosions in thick coal seams is another.

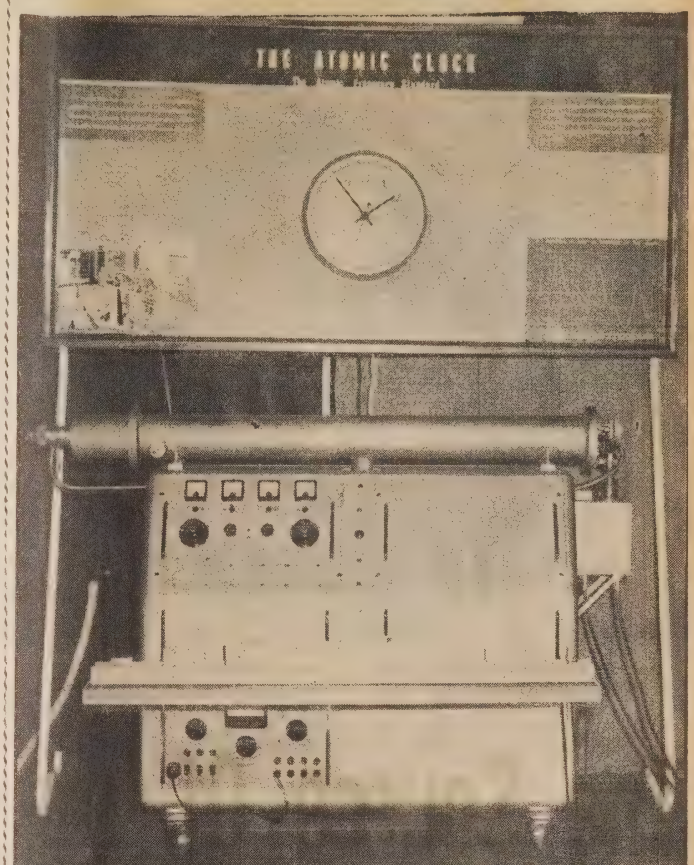
MOVING MOUNTAINS

As an aid to mining, there have been suggestions that big mineral deposits that are so low grade they can't now be worked at a profit could be profitably mined if broken up by an atomic blast. One buried bomb could shatter a whole mountain of low-grade copper ore, for instance, and the ore would then be ready for transportation to a concentrating mill. It might even be practical to leave the ore where it is and to leach the valuable minerals from it with liquids that would trickle down through the shattered formation.

The AEC has created a special department called Project Plowshare to investigate all such peaceful uses of controlled atomic explosions. The work is centred at the University of California's Radiation Laboratory at Livermore, Calif.

One of the Project Plowshare studies will determine the feasibility of using atomic bombs to dig a harbour on the coast of Alaska.

WORLD'S MOST ACCURATE CLOCK



The Atomic Clock on show at the "Pendulum to Atom" Exhibition at the Goldsmiths' Hall in London.

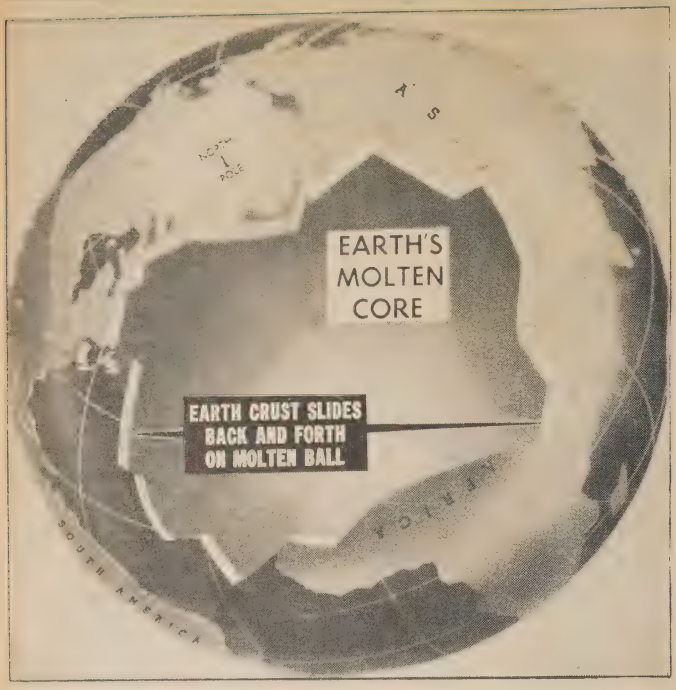
MAIN exhibit at the recent "Pendulum To Atom" exhibition at the Goldsmiths' Hall in London was the Caesium Atomic Clock.

Developed by scientists at the National Physical Laboratory, with an attendant mass of dials and lights, the atomic clock is so accurate that it loses only one second every 300 years and needs one gallon of water every minute to keep it cool.

It is possible to achieve this degree of precision because of the extreme stability of the fundamental properties of the atom, which are also independent of all external parameters, such as temperature, with the exception of magnetic field.

The caesium atom can exist in either of two stable states, and a transition from one state to the other absorbs or radiates energy at a discreet frequency. It is this frequency which forms the basis of the atomic clock. In the apparatus a beam of caesium atoms, generated at one end of a highly evacuated tube, passes through two focusing magnets arranged in such a way that the atoms are normally deflected away from an atomic detector placed at the far end of the tube. In the region between the atoms pass through a radio frequency magnetic field. When the frequency of this field is equal to the atomic frequency the atoms are excited from one state to the other and are then deflected on to the detectors. When the maximum number of atoms are detected the oscillator supplying the radio frequency field is tuned to the atomic frequency. This oscillator can then be used for calibrating other oscillators, or, if required, to operate a clock dial.

The National Physical Laboratory use the clock to calibrate the standard quartz oscillators — a process which takes but a few minutes compared with the months necessary to obtain the same precision by astronomical calibration. One of the main uses of the clock has been to determine the variations in the rate of rotation of the earth.



Cross-section of the earth showing the huge molten core and the crust which rides at times uneasily upon it. Eddies within the core are believed to be the cause of the earth's magnetic field.

The Source Of The Earth's Magnetism

Modern scientific research indicates that the earth's magnetic field is self-generated within the hot liquid core of the earth.

by Calvin Walters

BECAUSE of its practical value and the mysteries associated with terrestrial magnetism it has, for centuries, formed one of the most fascinating and difficult subjects for scientific investigation.

It was William Gilbert during the reign of Queen Elizabeth, who first showed that the earth acted like a magnet, but it seems that our friends, the Chinese, made use of the fact about 1,000 years B.C.

It is remarkable how the ancient Chinese keep bobbing up in scientific literature. They seem to have had a knowledge of a lot of things which we even now look upon as recent innovations.

They are reputed to have had flexible glass, tempered bronze as hard as steel, clocks, and a host of other mechanical devices and, apropos of our discussion, they had a "compass" to guide them in their wanderings over the vast plains of Tartary.

This took the form of a clever little image whose arm was actually a suspended magnet pointing continuously toward the south. The gadget was called a fsenan (which can be pronounced properly if you take out your teeth) and which meant "indicator of the south." All the ambassadors from Cochin China were presented with a fsenan (. . . see above) to guide them homeward after exchanging pleasantries with their northern neighbours.

The knowledge of the Chinese about this gadget was spread westward by the Arabs and Crusaders, but 2,000 years passed before the nations of Western Europe applied it to navigation.

Before the application of the magnetic compass, mariners guided their ships across the oceans by means of sightings of stars and landmarks. This was generally unsatisfactory, particularly during cloudy weather when stars were obscured. During such occasions the mariner trusted to luck, prayers or chucking some poor bloke overboard as a sacrifice to the gods of the deep or a feed for the mermaids, who were then supposed, to guide the ship on the proper course.

OPERATION OF MAGNET

It is the directive action of the earth's magnetic field on a magnetised needle which makes the magnetic compass workable. The general theory is well enough known and does not need explanation here.

The use of the magnetic field in navigation is perhaps the most widespread of all and its extension to aerial navigation has considerably widened its importance.

In surface and mine surveying the compass is also of great value, while in the search for oil and minerals much progress has been made because of the fact that such deposits have an influence on, and cause, local variations in the strength of the earth's magnetic field.

Anyone who remembers their school lessons in elementary physics will recall the fascinating experiment of placing a bar magnet under a sheet of glass or paper. If iron filings are scattered over the glass or paper and the latter tapped with the finger the filings arrange themselves in the form of outward curved lines stretching from one end of the magnet to the other.

These are lines of magnetic force and they run from one end — say the north end — out into space and back to the south end.

The earth's magnetic field behaves in the same way with lines of magnetic force radiating from one magnetic pole to the other through the space immediately surrounding the earth.

It is as though a large bar magnet was inserted into the centre of the earth with the ends pointing north and south.

The north and south magnetic poles are not in the same place as the poles which constitute the axis of the earth but are several hundred miles away.

Many of the early theories of terrestrial magnetism included such ideas as the centre of the earth being a huge lump of magnetised iron, that the heat from the sun causes it and so on.

LINES OF FORCE IN EARTH'S FIELD

The main objection to the latter is that magnetism cannot exist in a hot body above a certain temperature.

When it was later discovered that the interior of the earth is a molten mass of iron the theory that the centre was a magnet also became untenable.

A further difficulty lay in the discovery that the lines of magnetic force are not equal all over the surface of the earth and even at any given spot on its surface the strength of the magnetic field is forever changing.

This fact has made it necessary to take frequent magnetic surveys and draw maps of the earth's magnetic lines of force from time to time.

Such a map has lines drawn upon it connecting all the points of equal magnetic value. It looks something like the map shown in the picture herewith.

It is similar to the weather map where all the points of equal barometic pressure are joined together by lines called isobars, only the lines on the magnetic map are called isomagnetic lines.

MAGNETIC MAPS

These magnetic maps and surveys are necessary in order that variations in the magnetic field may be allowed for in reading the compass, for these variations have definite effects on that instrument.

Now, without going into detail over the matter, it has been satisfactorily proved that no external influence is directly responsible for the earth's magnetism. Nothing but a system of electric currents surrounding the earth could cause it but unless such currents were steadily maintained they would decay.

No such supply of inexhaustible power has been found.

We must look then to the earth itself as the source of the magnetism but if the earth itself was a large permanent magnet with a constant value of force, no variations in the field would be expected.

Not only has it been established that there is no sizeable amount of magnetism in the outer layers of rock and earth to a depth of 1,800 miles, but it has been shown to the satisfaction of scientists that the central core of the earth approximately 4,400 miles through is a molten mass mostly of iron.

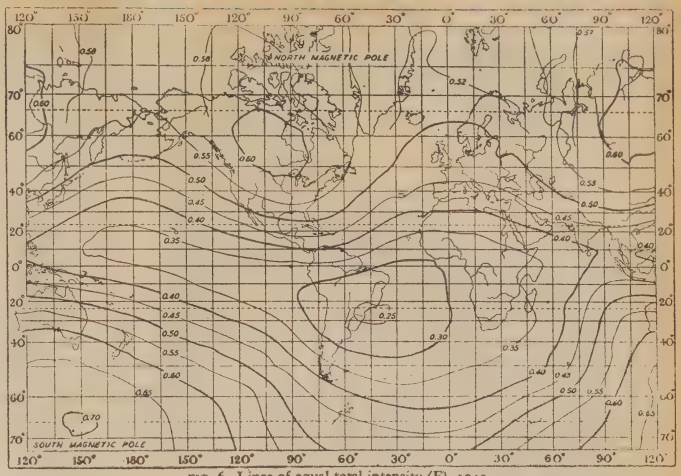


FIG. 6. Lines of equal total intensity (F), 1945

This diagram shows the lines of equal magnetic intensity in the year 1945.

As it requires a temperature of a few thousand degrees to keep this melted, no magnetism could exist there.

How do we know that the centre of the earth is a molten mass of iron?

By inference.

EFFECT OF EARTHQUAKES

A lot of scientific theories are inferred from the known behaviour of the laws of nature and this fact was inferred by the behaviour of waves caused in the earth by earthquakes.

When one of these formidable natural cataclysms occur it often rocks the whole planet to its foundations and causes certain waves to be propagated through the body of the earth.

These waves are picked up by observation stations all over the earth and are recorded on instruments called seismographs.

The waves are of two kinds called Push Waves and Shake Waves.

The Push waves are caused by the particles of the matter through which they pass oscillating back and forth along the path in which the wave is travelling. The particles do not travel along with the wave but just move forward and backward about the point they originally occupied so that when the wave passes, the particles are still in the same place, as it were.

These Push waves can travel through both a solid and a liquid. When a 'quake occurs, the Push waves sometimes, if the quake is powerful enough, pass right through the centre of the earth and are registered on the instruments on the other side.

Other Push waves travel through the outer layers but they are always bent upwards.

DENSER WITH DEPTH

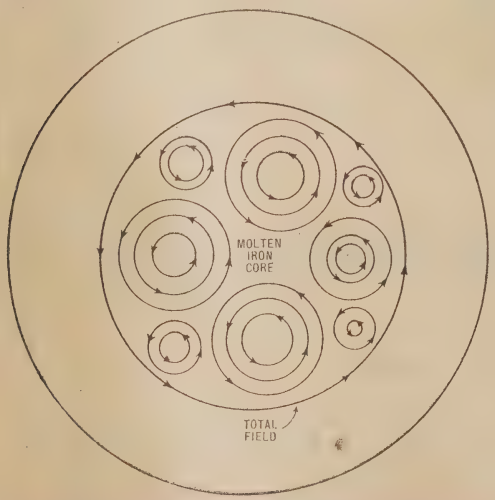
This proves that if this material was everywhere of the same composition it must become denser with depth. This is to be expected because the compression, of the deeper layers by weight of overburden, must be tremendous.

Now the Shake Waves are a different proposition. These are characterised by the fact that the particles of matter do not vibrate to and fro along the path of the wave but vibrate from side to side at right angles to the direction of movement of the wave.

These Shake Waves can only be transmitted through solid material and not through liquids. No Shake Waves have ever been recorded as having passed right through the centre of the earth and out the other side as Push Waves do.

This fact has led to the inference that the centre of the earth is liquid.

Over a long period, experience has given a record of the manner in which earth waves are reflected from various materials such as molten iron, granite, dense rock, sedimentary rock and ocean. The time differences between the arrival of waves travelling through various layers and reflected from lower levels

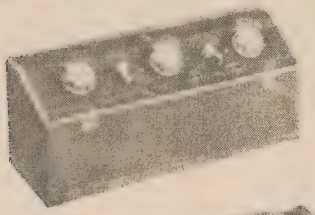


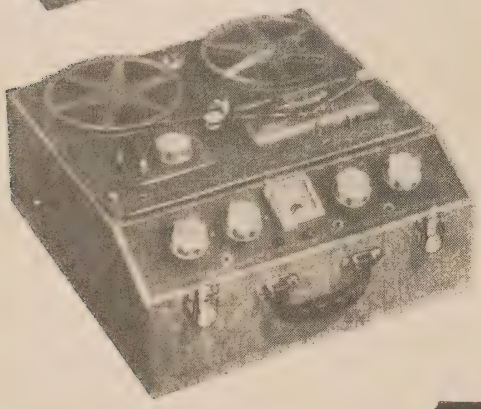
A section through the equator to show how the circulating currents within the earth's molten core produce a total magnetic field which is the magnetic field of the earth. The poles are perpendicular to the plane of this diagram.

A LOGICAL APPROACH TO stereo sound

To satisfy the growing interest in stereophonic sound, we now introduce a new Ferrograph Series 3S fitted with an additional "in line" (or stacked) head and the Stere-ad Unit—both of which are illustrated here. The Series 3S incorporates all the basic features of Ferrograph design, and, of course, functions as a normal monaural recorder and reproducer. But, at any later date, it can also play commercial or other stereophonic tapes (recorded by the stacked head process) by the attachment of an additional unit designated the Stere-ad. Essentially the Stere-ad Unit incorporates two matched pre-amplifiers (one for each track) together with a second 2½ watts power amplifier. Connecting the Stere-ad Unit to the Ferrograph 3S completes the connections whereby the two pre-amplifiers and the two power amplifiers (one already in the Ferrograph and the other in the Stere-ad) automatically provide a 2 x 2½ watts matched stereophonic output for feeding into any appropriate external speaker system.

This logical approach to the problem will permit the owner of a Ferrograph 3S to enjoy all the thrills of true stereophonic sound at any future time at small cost without discarding any existing equipment.





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has been tabulated. In this way a fairly accurate estimate has been arrived at of the composition of the various layers of the earth and the central core.

This brings us then to the real meat of our subject, and the question as to how the earth's magnetic field could be generated inside the earth itself.

To summarise what we have found so far produces somewhat of a paradox. We seem to have got into a bit of a mess. Firstly there is no external influence which directly produces the earth's magnetic field. Secondly there is no magnetism in the outer crust and thirdly magnetism cannot exist in the liquid core. So where do we go from here?

There is one thing we can infer which would explain the matter very satisfactorily. The earth could be a giant dynamo.

OPERATION OF DYNAMO

A dynamo produces electricity by whirling a coil of wire in a magnetic field. The magnetic field is produced by feeding electricity through a coil wrapped around an iron core. Another coil of wire, the armature, is whirled through this field and electric currents are induced in the armature. Portion of this current is fed back into the field coils to create the magnetism. The armature is revolved by steam turbines or other external means.

If it were possible to feed the electricity generated by the dynamo into an electric motor which in turn drove the armature of the dynamo, we would get some sort of perpetual motion. This is not possible because the resistance of the wires in the system would cause the electricity to fade out and the system would cease to function. In other words the amount of electricity needed to drive the motor at the required speed is more than the dynamo can generate.

It is a well-known electrical phenomenon that if a current of electricity is fed into a coil a magnetic field will be produced around the coil. If now a metal disc is spun over the coil electric currents will be induced in the disc. Michael Faraday invented this sort of simple dynamo in the 1830s.

If the induced current could be fed back into the coil the apparatus would go on indefinitely if it were not for the fact that here again the resistance of the disc would kill the current.

LARGE DISCS

It has been shown that the larger the disc the better chance it has of being self-sustaining. To carry this further if the disc was equal to the diameter of the earth the currents induced in it would take so long to decay that the scheme would be virtually self sustaining.

Now what has all this to do with terrestrial magnetism?

Just this. The earth revolves on its axis. It is very large. It has a liquid core of metal. This provides all the elements of a huge dynamo except for one thing. We must commence operations with an electric current to start the process off.

The existence of an electric current inside the earth is not hard to assume. It could have been brought about originally by differences in temperatures or the electrolytic action between two different metals. It could have been brought about in a dozen different ways just as it is taking place throughout nature all the time and in the laboratory.

These currents would at first be very weak but over the course of time they would be amplified by the system.

It has been calculated that a current generated in the earth's core would take 10,000 years to decay and whilst one is decaying another is being built up, and so it goes on forever.

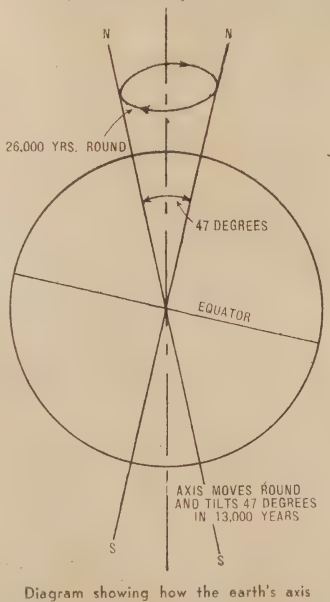

Diagram showing how the earth's axis moves around.

And now we have an electric current, an iron core and the spinning element of the earth. All we have to do now is to get these currents circulating so that they act like the current in a coil.

In order to produce the magnetic field as we observe it the currents must circulate in a closed circuit.

INTERNAL WHIRLPOOLS

If the earth was cut right through the equator at right angles to its axis the kind of circulation we would need would be a lot of whirlpools in the liquid core arranged concentrically around the axis. It would be just as if a lot of large tubes were dropped with their open ends up and down around the axis. Fill these with liquid iron and stir it round and round until the liquid in each tube is revolving like the water going down the bath tub hole.

Put an electric current in each tube and it will circulate. We then have the equivalent of a lot of coils with currents in them.

These would produce magnetic fields with the North Pole at the top and South Pole at the bottom exactly as we find it in practice.

The separate magnetic eddies would travel around and cause the observed changes in the magnetic fields as reflected at the outside.

The currents would also vary in strength from time to time as they decay and build up again and thus cause other fluctuations in the strength of the magnetic fields exactly as observed at the outside.

(Continued on page 119)

MAGNETIC FIELDS IN PROMINENCE

The shape of this huge solar prominence photographed with a coronagraph at the University of Colorado suggests that it travels along magnetic lines of force.

TRANSISTOR TRANSFORMERS

These transformers have been designed in the Rola Laboratories specially to meet the requirements of Australian radio set manufacturers for highly efficient driver and output units which provide a good frequency response when used with standard type low-powered transistors.

They are intended to operate into a standard 3.5 ohm impedance loudspeaker voice coil. In addition to Types DR17 and TR18 which have been designed for transistor portables, Rola also makes other types of transistor transformers. Specifications of some of these are listed below.

ROLA TRANSISTOR TRANSFORMER SPECIFICATIONS

TYPE	DESCRIPTION	IMPEDANCE OHMS	OUTPUT POWER 6 v.	OUTPUT POWER 9 v.
DR17	Driver transformer	3,000 — 2,000 c.t.		
TR18	Output transformer	375 c.t. — 3.5	175 mW	300 mW
DR4	Driver transformer	3,000 — 1,300 c.t.		
TR7	Output transformer	420 c.t. — 3.5	150 mW	250 mW
TR8	Output transformer	300 c.t. — 3.5	200 mW	375 mW

HIGH EFFICIENCY LOUDSPEAKERS

Two small high-efficiency Rola loudspeakers have already been developed for use with transistor or conventional battery-operated receivers and amplifiers. Others are on the way. For transistorised portables use a Rola Model 5F. For miniature transistor receivers we recommend the new Model 4C-05A fitted with an F44 diaphragm. This speaker measures only $4\frac{1}{8}$" overall by $1\frac{3}{4}$" deep, is light in weight—only $6\frac{3}{4}$ oz. (without transformer), yet has an efficiency equal to that of the earlier Model 4F. Its low cost, small dimensions and light weight make it ideal for miniaturised battery or transistor receivers.

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Technical Review

SOLID STATE PANEL AMPLIFIES X-RAY IMAGES

HIGH CONTRAST AIDS PICTURE DETAILS

Last month we gave some general information on a new device originated by RCA for the direct amplification of x-ray images This article from "Electronics" was written by B. Kagen of RCA laboratories and provides a more detailed description of a most interesting equipment.

IMAGE intensification for X-ray analysis is approached in a new manner with a panel amplifier using solid-state techniques. The amplifier is in the form of a thin plate similar in outward appearance to the conventional fluoroscope screen.

Since the amplification occurs entirely within the panel itself, no complex and bulky amplifying equipment is required external to the panel. Size of the panel is arbitrary and only a simple power supply is required for operation.

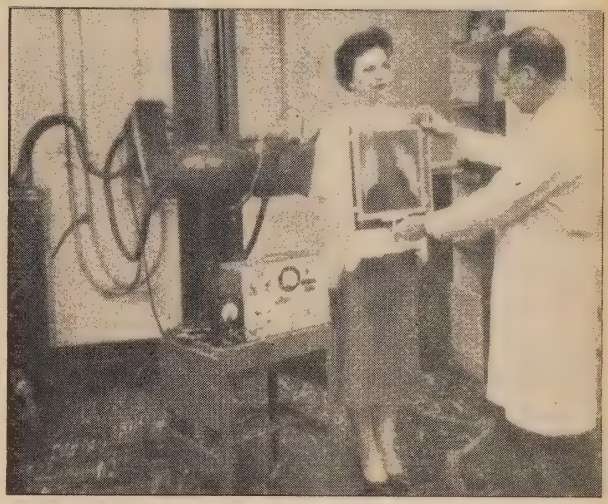
Figure 1 shows an amplifying panel in its simplest form. Adjacent layers of photoconductive and electroluminescent phosphor materials are used. Electrodes are provided on the outer surfaces across which alternating voltage is applied. In the absence of X-rays, the thicker, high-impedance layer of photoconductor limits the flow of current through the phosphor to a low level.

But if X-rays excite a local area of the photoconductor, its conductivity is increased and current flows through the corresponding area of the phosphor with the emission of light.

INSULATING LAYER

To prevent output light from feeding back and exciting the photoconductor, a thin insulating opaque layer is placed between the photoconductor and phosphor layers. For viewing, the electrode in contact with the phosphor is made transparent. To permit X-rays to penetrate to the photoconductor, the opposite electrode is made of a thin material consisting for example, of silver paint

Photoconductor and phosphor layers have a total thickness of about 10 mils Consequently, a pattern of X-rays can produce a pattern of output light with little loss in resolution due to spreading of the currents.



Actual use of 12in amplifier containing within its back cover the auxiliary phosphor layer. Connected to the amplifier is its 400-cps supply and also shown is a meter for measuring current flow through the photoconductor.

In effect, the photoconductor is a distributed valve, controlling the flow of alternating currents into the phosphor layer at each point. With sensitive photoconductors and efficient phosphors, an output light can be produced whose energy is many times greater than the energy of the incident X-rays.

The phosphor layer, consisting of a powder bonded with plastic, can be fabricated readily into uniform, large-area layers, one- to two-mils thick by conventional techniques such as spraying.

Although many photoconductive materials are known, they are usually either in the form of small crystals of the order of millimetres in size or thin evaporated or sintered layers

For an amplifying panel, a large-area photoconductive layer is required about 10 mils thick. This requirement is met by use of a recently developed CdS powder photoconductor which can be bonded with plastic and fabricated easily into large-area uniform layers. In addition, this powder has high sensitivity and low dark current; conditions required by the amplifier. Capacitive impedance of the photoconductive layer is much higher than that of the phosphor layer.

HIGH GAIN PANEL

Much higher sensitivity can be obtained from the photoconductor by passing DC through it instead of AC. To accomplish this and provide the necessary AC for the phosphor layer at the same time, a circuit developed earlier for panel light amplifiers is used. A cross-section exaggerated in thickness is shown in Fig. 2. The darkened areas represent a single picture element excited by the X-rays. As indicated, each phosphor element is excited by two photoconductive elements

Operation of the high-gain panel is explained in Fig. 3. By inserting DC supplies of opposite polarity in series

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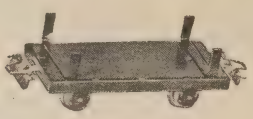

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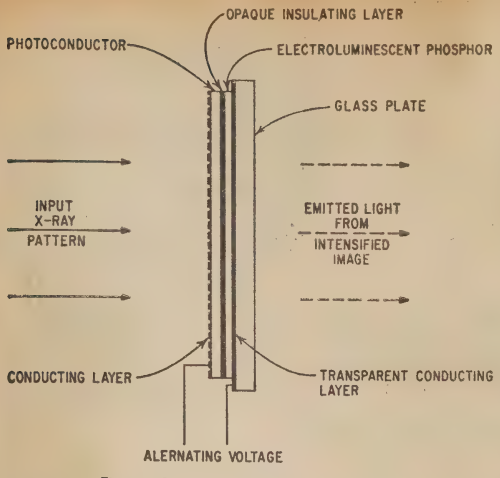

Fig. 1—Simple form of amplifying panel.

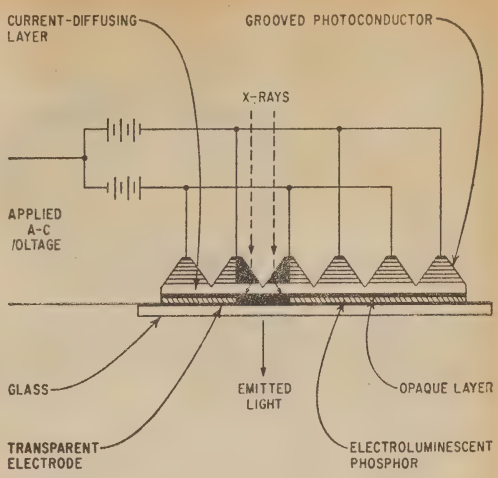

Fig. 2—Cross-section of amplifying fluoroscope screen.

with the photoconductors, unidirectional voltages are applied as shown to the right. Since the photoconductive material has a non-linear voltage-current relationship, most of the current flow occurs in the neighbourhood of the voltage maxima.

Resulting charging and discharging of the phosphor element through the respective photoconductors each half cycle provides alternating current required for exciting the phosphor.

DIFFUSING LAYER

The partially conducting current, diffusing layer shown in Fig. 2 provides DC conductivity between adjacent ridges of the photoconductor which are slightly separated at their bases. This conductivity was chosen to limit the current spread to about one groove width. In present amplifiers, photoconductive grooves are spaced 25 mils on centres. This allows the separation of picture details down to about this size.

Because of the build-up properties of the photoconductor, an output image does not appear immediately when the panel is excited with X-rays. At the low X-ray levels used in medical fluoroscopy, buildup time is in the order of seconds.

Figure 4 shows a curve of panel light output as a function of incident X-ray level with a 10-sec excitation time. By comparison, light output of a conventional fluoroscope screen is also shown. In medical work X-ray levels on the screen below 200 milliroentgens/min are common.

At these input levels, the panel amplifier produces images whose output light is as much as 100 times greater than the fluoroscope screen. In addition, as shown by the high slope of the amplifier characteristic, output light is roughly proportional to the third power of the input X-ray level.

Compared with the conventional screen, whose characteristic is linear, the amplifier output image has a much higher contrast. High contrast is desirable for detecting small differences in density or thickness of the body.

Figure 5 shows a reproduction of an output image produced on a 12in x 12in amplifier panel. To simulate absorption and scattering of X-rays in the human body, about five inches of Presdwood sheets were used between which were placed a variety of objects. At the centre is a human femur or thigh bone with a nail through it as would be used to repair the bone in a hip-pinning operation.

Also shown are a variety of metallic objects and an additional piece of bone which extends above the amplifier where a section of a conventional fluoroscope screen is located. Because of the low output light, no image is recorded from the conventional screen.

RECIPROCAL RELATIONSHIP

A roughtly reciprocal relationship exists between input X-ray level and exposure time required to produce a given output light. For example, if exposure time is doubled to 20 secs, X-ray level can be cut in half and gains up to 200 times over the conventional screen can be obtained. Reciprocity exists for excitation times up to about 30 sec and below 0.01 sec.

In addition to its build-up property, the panel has a long decay time after the X-rays are cut off caused by the characteristics of the photo-conductor. In practice, the gradully decaying image can be viewed for as long as 30 sec with the X-rays off

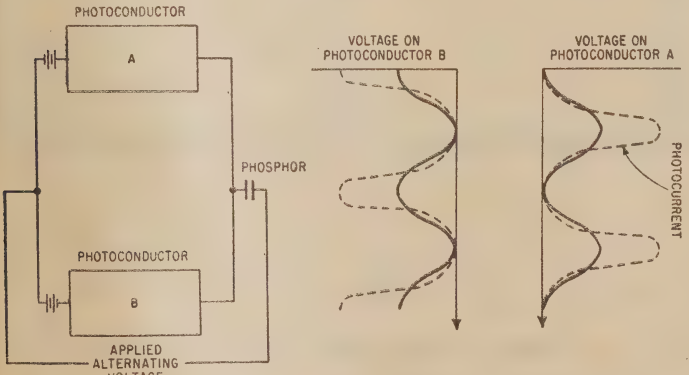

Fig. 3—Amplifier element with biased AC operation. DC supplies of opposite polarity inserted in series with photoconductors apply unidirectional voltages as shown at right Most of the current flow occurs in the neighborhood of the voltage maxima.

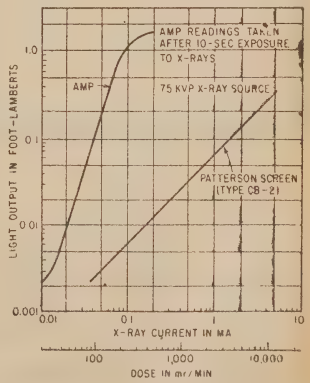

Fig. 4—Input-output characteristic of the amplifier compared with conventional fluoroscope screen.

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Figure 6 shows a set of decay curves obtained by exciting the amplifier for one sec with different input levels. These curves are approximately straight lines with a decay characteristic. This indicates the output to fall to 1/e in roughly three seconds.

In extended viewing of a stationary X-ray image, the long persistence of the amplifier allows a saving in dosage to the patient since the image can be studied with the X-rays off. When higher X-ray voltages are used, such as in the X-ray therapy and industrial applications where shielding is difficult, viewing of a bright image can be done in complete safety with the X-rays off.

If it is desired to photograph the screen, the much higher light output and long decay of the amplifying panel is of potential advantage. It enables either a reduction in X-ray exposure or use of lower-aperture, less-expensive optics.

In practical applications, ability to view a new image is sometimes desired

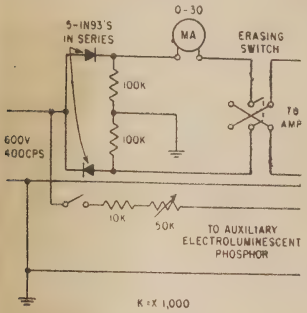

Fig. 8—Control circuit of the portable supply.

without waiting for the previous image to decay gradually. This can be accomplished by making use of a special property of the photoconductive material. After an image is built up, polarity of the DC supplies is reversed.

Conductivity of the photoconductive powder in the reversed direction is suddenly reduced to a low level and output of the panel is cut off. Since reverse conductivity is determined somewhat by current flow in the initial direction, it is preferable to flood the entire amplifier with radiation before reversing the voltages.

The complete arrangement for erasing is indicated in Fig. 7 with thickness of the layers again exaggerated. In addition to the reversing switch, an auxiliary electroluminescent phosphor layer is placed adjacent to the amplifier

Since the grooved photoconductor is sensitive to visible light as well as X-rays, it is more convenient to flood it with light from the auxiliary phos-

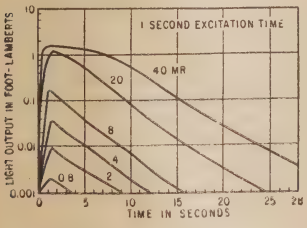

Fig 6—Amplifier decay following excitation with different x-ray inputs

Fig. 5 — Amplifier output. See text for detailed explanation.

☆

phor layer. By making the phosphor layer thin, about one mil thick, and supporting it on a five mil Mylar sheet, X-ray absorption caused by the introduction of these layers is negligible.

To provide a transparent electrode, surface of the Mylar in contact with the phosphor is coated with an evaporated aluminium layer of about 40 per cent ligth transmission

In operation after an output image has been excited by the X-rays, the slowly decaying image can be viewed for an arbitrary time When erasure is desired, the auxiliary phosphor layer is switched on for one sec. or less to flood the entire panel, followed by a reversal of the bais voltage. Following the erasure, the entire amplifier is dark and can be excited with a new image as soon as desired

Bias light provided by the auxiliary phosphor layer is also useful in priming the amplifier prior to exciting it with an X-ray image. In some cases, as a result of the erasing action or if the amplifier has been unexcited for a long period, current through the photoconductor may be below the threshold level required to produce any light output on the amplifier.

PRIMING LIGHT

To reduce X-ray exposure on the amplifier to a minimum when building up an image, it is desirable to prime it initially with the auxiliary light until the threshold output light is reached.

To prevent exciting the amplifier by ambient room light, the back side of the panel with the auxiliary phosphor layer indicated in Fig. 7 is enclosed in a light-tight plastic cover which is X-ray transparent.

To avoid the need for DC supplies, the control circuit of Fig. 8 is incorporated. This circuit uses oppositely polarised rectifiers to provide DC to the two sets of photoconductive ridges. As with biased AC current flow through adjacent photoconductive ridges occurs at alternate half cycles For equal peak voltages applied to the amplifier gain with diodes is almost as high as with biased AC. Difference in gain is caused by the change in wave shape of the applied voltage

The auxiliary phosphor layer, having a capacity of about 0.1 uf is also excited from the 400-cps source. To control the output light and lower the voltage, appropriate dropping resistors are used

For the 12in amplifier current of about 30 ma is required Since current flow through the photonconductor is a measure of output light, it is convenient to monitor this current with a DC meter in series with one set of diodes.

In cases where the panel is observed during the decay period with the X-rays off, the current meter, remotely positioned, can be used to indicate when the panel has reached full brightness. In place of the meter or in series with the second set of diodes, it is convenient to use a relay set to automatically shut off the X-ray source when the image has reached full brightness

The present amplifying panel with its build-up and decay properties is potentially useful for the viewing of nonmoving

(Continued on Page 27)

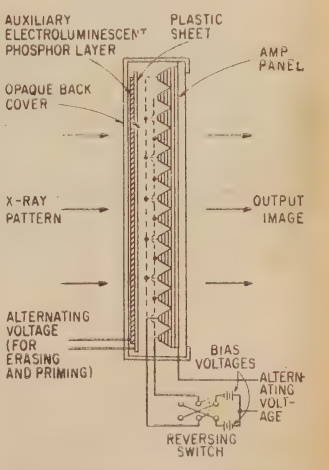

Fig. 7—Cross-section of complete amplifier with erasing means

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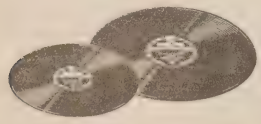

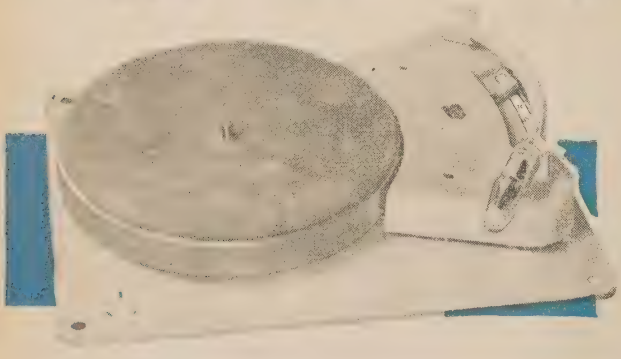

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UNIQUE P.A. SYSTEM AT BRUSSELS

SOUND DISTRIBUTION BY VHF/FM

One of the maior events in Europe this year has been the Brussels Exhibition, in which many countries participated with elaborate pavilions and exhibits. This article, from "Wireless World," describes the unique PA system which served the vast area in which distribution cables were dispensed with in favour of a VHF radio network.

THE public address system used at the Brussels Universal Exhibition is of more than usual technical interest. It was developed on the bold and imaginative lines which characterised the whole exhibition, and was a practical demonstration of Belgian skill in the electronic arts.

At an early stage it was decided that a low-level, multiple-source system would be necessary to cover the 500 acres of exhibition grounds so that everyone could hear announcements clearly and without conflicting echoes; and also to enable several types of background music appropriate to the environment to be diffused simultaneously in different sections of the exhibition grounds.

AVOIDING CABLES

A second, and more interesting decision, was to avoid the use of cables and to adopt a radiated VHF/FM distribution system. Although more expensive (each loudspeaker was provided with its own power amplifier and radio receiver), this system more than justified itself during the opening week when it was able to function without interruption in the midst of the usual exhibition last-minute rush to complete roads and buildings which would have played havoc with a complex and necessarily temporary cable system.

Subsequently, minor adjustments of the positions of loudspeaker units could be made with ease, as mains supplies were available within a few feet of any point in the grounds.

Five separate radio transmitters were installed on the first floor above the main entrance hall of the exhibition, feeding simple dipoles on the roof just behind the facade.

These operated on five channels, allocated by the Belgian Post Office, in the frequency range 76.6-78.35 Mc/s, and were designed and built by the Societe Belge Radioelectrique and employed the FMQ directly-modulated crystal system of frequency modulation.

The output power was 500 watts so that an ample field strength was available not only in the exhibition grounds but throughout the greater Brussels area. Close attention was paid to linearity throughout the transmitter, not only in the interest of good quality but also to avoid spurious frequencies which might cause interference with adjacent police service channels.

DEVIATION

The transmitter is linear for deviations of well over 100 kc/s, but the maximum is limited to the standard 75 kc/s. When "Wireless World" was privileged to visit the station it was noted that the deviation meters were rarely showing more than 15 or 20 kc/s on peaks.

These meters were not solely relied upon for monitoring, and the master volume indicator was a calibrated CR/tube showing the instantaneous AF/wave-form. Most of the music and many of the routine announcements came from tape records, and there was, of course, a studio microphone for special announcements.

The transmitters were switched on in April and ran continuously until October, when the exhibition closed. As some parts of the exhibition were open from 10 a.m. to 4 a.m., there was little point in going through the warming-up processes for the sake of less than six hours' saving of current.

The receiver-amplifiers (no fewer than 450 in all) also ran continuously throughout the exhibition period, partly to avoid the possibility of locking on to the wrong channel when warming-up but principally to keep the equipment dry (most of the units were exposed to the elements in flower-beds and near fountains!).

Two stages of r.f. amplification preceded the mixer as there were no external aerials, and there were three i.f. amplifying and limiting stages, with the limiting function distributed throughout this section of the receiver.

A balanced ratio detector followed, from which an a.f.c. voltage was derived to control the local oscillator through a conventional reactance valve circuit. Two EL84s in push-pull in the output stage of an a.f. amplifier were rated to deliver 14 watts. No a.f. gain control was provided and the sound volume was determined solely by the modulation deviation of the transmitters in the control centre.

LOUDSPEAKERS

A wide variety of loudspeakers of different Continental and British makes were adopted for the many forms which the sound reproducing units took. It is gratifying to be able to record that British units (Goodmans) were chosen for units near the main entrance gates, for the music background to the Garden of the Four Seasons, where better than average quality was called for, and for monitoring purposes in the control rooms.

The types chosen were "Axiom" 150 Mk. IIs in special enclosures with ARU acoustical resistance vents, supplemented in some cases by "Axiettes." In the Grand Auditorium of the Exhibition the monitoring loudspeakers were Axiom 80s.

We were particularly impressed with the sound quality in the Garden of the Four Seasons where the loudspeakers had been incorporated in the trellis work separating the sections of the garden. It was free from every kind of distortion, including the stridency which might have been expected if there had been any striving after "hi-fii."

Throughout the rest of the exhibition there was a complete absence of the multiple echoes which are so often associated with multiple-source p.a. systems. Even flutter echoes between parallel walls of pavilions, which we understand were experienced in the early stage of testing, were conspicuous by their absence when we visited the exhibition. These were eliminated either by arrangement of the loudspeaker groups or by reversing the phasing of the inputs to units within the group.

RCA DEMONSTRATES STEREO ON AM

A NEW radio broadcasting system that provides full stereophonic sound through a single receiver and dual speakers on the regular AM broadcast band was unveiled recently by the Radio Corporation of America.

The experimental system, described by Dr. James Hillier, Vice-President, RCA Laboratories, as "perhaps the longest forward stride in the standard radio broadcast field in nearly thirty years," was demonstrated for the first time to an audience of broadcast station executives at RCA's David Sarnoff Research Centre at Princeton, New Jersey.

Two separate sound channels, picked up by two separate microphones or by a stereo disc or tape pickup at the studio, are transmitted on the regular broadcast frequency. A standard AM frequency is made up of a carrier wave and two symmetrical sidebands of slightly higher and lower frequencies to either side of the carrier. In the stereo system demonstrated to the broadcasters, each of the stereo channels is carried by one of these sidebands.

In the stereophonic AM receiver, the two sidebands are separated and fed to two speakers, left and right, to reproduce the stereo effect picked up at the studio. In a present conventional AM receiver, there would be no separation of the two sidebands, so that the program would be heard in conventional fashion without the stereo effect.

The stereophonic receiver also can pick up non-stereo broadcasts and play them through either speaker or both, without any stereophonic effect.

It was demonstrated to the broadcasters with music from a stereophonic tape recording, broadcast over a laboratory-type AM stereo transmitter and picked up by the stereophonic receiver for playing through dual speakers of the type used in the RCA stereophonic phonograph system. The receiver also picked up a regular AM non-stereophonic broadcast from radio station WRCA in New York to demonstrate its adaptability to existing broadcast service.

SOLID STATE PANEL AMPLIFIES X-RAY IMAGES

(Continued from Page 25)

parts of the body. In these applications, its bright image permits working in a moderately lit room without dark adaptation.

By increasing the contrast of the X-ray image, it aids in the perception of details. Because of its amplifying action, relatively low X-ray dosages are required.

At high X-ray voltages, where shielding is a problem, its long persistence image can be viewed at close range with the X-rays off.

Since output light is relatively high, it can also be conveniently used with an industrial TV system employing a vidicon pickup tube where remote viewing is desired.

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94B Pattern Generator	163 0 0	162 4 0	162 4 0
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191A R.C. Oscillator	61 2 6	60 16 6	60 16 6
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71A Multi-range Meter	26 13 0	26 10 6	26 10 6
72A " " "	32 19 3	32 16 0	32 16 0
122A " " "	15 6 6	15 5 0	15 5 0
150A Output Power Meter	73 0 0	72 13 0	72 13 0
313D Adaptor	11 2 6	11 1 6	11 1 6
315C H.V. Probe	11 13 0	11 12 0	11 12 0
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471 H.V. Probe	11 13 0	11 12 0	11 12 0
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AT200M Field Strength Meter	169 8 6	168 12 0	168 12 0
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NEWS AND VIEWS OF THE MONTH

Electronic forecasts

DANISH weathermen admit an electronic brain gives better forecasts than they do.

They had fed the electronic brain with information available to meteorological experts in September.

They asked the brain to predict the weather for the following week.

The brain correctly predicted a storm and did a far better job than the weathermen.

Dr Lang Rasmussen, of the Copenhagen Meteorological Institute, said: "The electronic brain is not distracted by the decades of experience that sometimes sneak into the work of the human forecasters and slant their predictions."

Next winter the brain will take over more and more of the calculations at the institute.

Dr Rasmussen said weathermen were giving in because better forecasts were more important than professional pride.

Seeing by starlight

TROOPS may be able to see military objectives at night with a new device called a cascaded photo-sensitive image intensifier. Extension of the range and sensitivity of astronomical telescopes, low radiation level X-rays and viewing minute light flashes emitted by nuclear particles are other expected uses.

The new development differs from other night vision devices. No artificial sources of radiation such as radar or infra-red are required. It is also said to be much less complex than low-level light intensifier TV systems.

This unit gathers reflected starlight and diffused light from skyglow falling on the objective. The intensity of light furnished by the stars is so low that it is of limited value to the unaided eye in seeing military objectives at night. With the new intensifier, however, it will be possible to see objects at greatly increased ranges.

Heart of the instrument is a cascaded image tube—actually two tubes. They operate through an optical system that focuses the light reflected from objects in the field. The first tube acts as a pre-amplifier. The second tube further amplifies the light and presents the image on a viewing surface.

The image tube operates at approximately 25,000 volts. A six-volt battery is the primary power source with transformers and transistors used to step it up.

Russian colour TV

MOSCOW will have its first regular colour television broadcast in December, according to reports, which quote the head of the Experimental studio of the Russian Communications Ministry, M. Novokovsky.

Up to now, trial broadcasts have been issued daily to a few experimental sets in Moscow, and have been of good quality.

The first colour TV sets will cost four times the amount of the ordinary set at first, but the prices were expected to fall in about a year, when mass production is under way.

A new 3D radar device, enclosed in a plastic bubble for security reasons, recently on view by the US army. It gives simultaneous readings of bearings, distance and altitude and is considered a most important advance in electronic detection. It is shown with a Jupiter rocket, apparently tilted due to camera angle.

Planetary contamination

AN international scientific group says that clues to "the origin of life" may be buried in the dust of the moon, and that primitive forms of life like some on earth may exist on Mars and possibly Venus.

For these reasons, nations bent on rocket exploration of the moon and planets "in the next few years" must take every precaution not to contaminate them with living or "pre-life" matter from the earth.

Such contamination might destroy scientific efforts to find life clues on the moon and jeopardise "the most challenging of all planetary studies, that of extra-terrestrial life."

The warning was made in a committee report to the International Council of Scientific Unions (I.C.S.U.) holding its eighth general assembly in Washington.

The anti-contamination report particularly warned against "disturbing" the moon with explosives, conventional or nuclear; chemical markers involving large quantities of material, rocket exhausts, flares, or giant molecules which constitute the chemical foundations of living organisms.

The report estimated the total amount of matter in the moon's extremely thin atmosphere at no more than 10 to 100 tons.

Therefore, any attempt to mark the moon for observation purposes by rocket-borne explosives or chemicals could put so much foreign material into the lunar atmosphere as to ruin attempts to learn its original nature.

EFFECTS OF GASES

So could rocket gases from decelerating space-craft trying to land on the moon.

Concerning contamination with organic molecules, the report said:

"The basic problem concerning the origin of life is how complex molecules (on the earth they are based on carbon) came to be built up and become replicated.

"It is conceivable that the interior of the moon dust may provide some valuable clues in this direction."

Introduction of giant molecules from the earth might "cause a serious upset in the lunar processes" by providing new patterns "for pre-life growth."

The same thing applies to the planets. But the main danger there is contamination with living things.

There "is a reasonable possibility that the conditions on Mars are such that some terrestrial organisms might grow," distorting the Martian balance of nature.

"It is therefore of the greatest importance," the scientists said, "that space vehicles should not land either accidentally or deliberately on Mars (and possibly also Venus) unless all precautions have been taken to exclude living organisms from them."

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SCOPE LABORATORIES MELBOURNE

Russian TV satellite

A SOVIET satellite for relaying TV broadcasts appears to be in the planning stages, with scientists anxious to carry out preliminary tests of both the rocket vehicle and the broadcast relay apparatus.

Such a scheme was recently described by scientist Druzhkin and engineer Sorin in the magazine "Knowledge Is Strength." They envision for Moscow a future audience taking in Europe, Asia, Africa and Australia.

Decision to push ahead with such a plan was made last January, they say, by the TV section of the U.S.S.R. Scientific and Technical Society of Radio Technology and Electrical Communications. The group at that time endorsed a study of theoretical and practical problems connected with such a launching.

"There is every reason to expect," the scientists say, "that this launching can be readied and carried out now."

The TV satellite would give the Russians an electronic foot in the door of countries inhabited by some 2.2 billion persons. It would complicate the task of policing the international airwaves, proposed to the U.N. by President Eisenhower. The President called for a U.N. monitoring system as part of a six-point plan for ending Middle East tensions. But his speech and other General Assembly proceedings broadcast by the Voice of America were jammed by 2,000 to 2,500 transmitters in the Soviet Union and other Communist countries.

GREAT HEIGHT

Druzhkin and Sorin say a relay satellite should be fired to a height of 36,000 kilometres (22,350 miles), at which it would move at an angle speed equal to that of the earth's rotation around its axis; it would, in effect, hang over a given spot on the earth's surface.

They estimate two kilowatts are needed to power the transmitting apparatus. They propose to use solar batteries at first and switch later to small nuclear reactors.

Construction of ground and satellite instrumentation and the launching of the satellite's rocket pose complicated problems, the scientists say.

Druzhkin and Sorin suggest that Russia can get more mileage out of her propaganda roubles through such a scheme than through conventional broadcast techniques. The cost of such a project, they say, would be several times less than the building of thousands of TV centres, and underground and overland relay stations, even if a new TV satellite must be launched every year.

Steady reception would be assured, they say, throughout the Eastern Hemisphere from the 82nd Parallel north to the 82nd Parallel south, possibly even in higher latitudes, and also in the Western Hemisphere.

To fight submarines

NORWEGIAN scientists have developed an unmanned, automatic-loading anti-submarine weapon.

Known as the Terne, the weapon can launch six rocket-propelled depth charges.

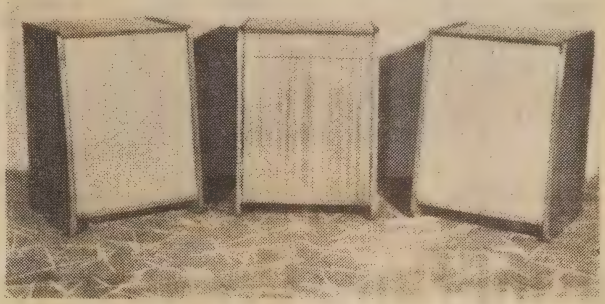
Firing angles and aiming are carried out automatically by a predictor.

The captain of a ship can decide, by pressing buttons, whether he wishes to fire a salvo or single shots, whether he wishes to use a proximity or time fuse.

SENSATIONAL RELEASE!

STEREOGRAM CABINETS

Solving all those equipment housing problems. Audio Engineers now present a new comprehensive range of cabinets.



The "G" series stereogram cabinets (illustrated). Immaculate control and speaker cabinets matched in size, colour and finish, height 29in. width 21½in. depth at base 18½in. Speaker cabinets are covered at front with plastic grille cloth, fully felt lined, with provision for Acoustic Resistance Unit, type 172. 12in speaker and optional tweeter.

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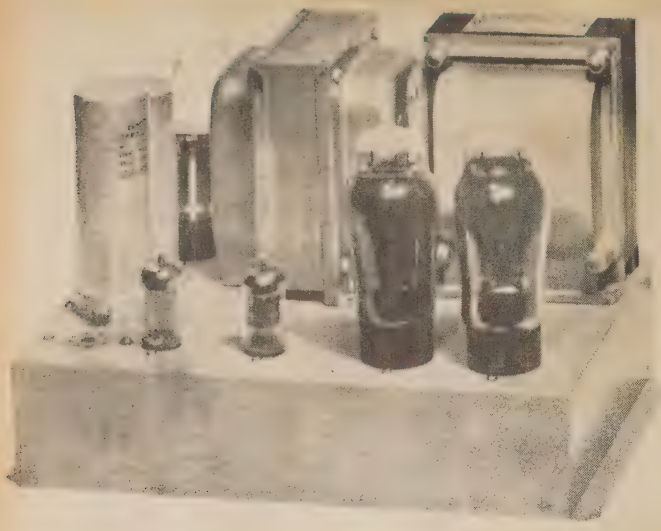


A second version of the 17-watt amplifier using a different set of transformers from those illustrated last month.

Amplifier Response & Stability—Part Two

This article continues discussion of Amplifier performance, including the results of tests made with practical designs. It includes a suggested form of layout suitable for most push-pull amplifiers of several sizes using the 17 watt circuits as an illustration.

by John Moyle

LAST month, the importance of the output transformer in setting amplifier performance was considered in some detail with particular reference to high frequency stability.

Four commercial amplifiers were analysed with the aid of photographs taken from the screen of a cathode ray oscillograph, and the same tests were made with the 17-watt ultra-linear amplifier which has proved so popular among our readers.

In this article, some further points on transformer behaviour are discussed with a view to illustrating what happens in some practical designs when feedback and phase correction methods are used.

As was pointed out last month, the application of feedback from the voice coil to the input circuit of an amplifier will reveal peaks in transformer response which are not normally observable without feedback.

These peaks, or even discontinuities in response not large enough to be graced with such a description, can cause phase changes in the amplifier so that the voltage fed back to the input is no longer negative but positive, under which conditions it can produce oscillation or near oscillation, and will do so if the feedback is sufficient and correction is not applied.

Even if it is, oscillation dangers, at both high and low frequencies, are the limiting factors in deciding how much feedback can be applied in a given design.

It was pointed out that, if the transformer resonances are comparatively low down in the response curve, it is almost impossible to deal with them without prejudicing amplifier response even within the audible range.

The best transformers in this regard are those having no more than one major peak, as low in amplitude as possible, and positioned well up in the supersonic region.

The ultra-linear connection of output valves is most valuable in obtaining a clean response and good square wave performance, for it is in effect a local feedback loop applied over the output stage. As such it confers upon the amplifier all the benefits of feedback in reducing distortion and in lowering effective output impedance.

Invariably the behaviour of an amplifier will be improved in almost every particular when the output connection is changed from "pentode" connection to ultra-linear, even when the same transformer is used.

But the general pattern of improving high frequency stability by standard correction methods will apply equally to either connection and by plotting response curves for various operating conditions, it is interesting to see how the results are modified.

The picture becomes even more complete if square wave tests are made at the same time, and we have done this in order to more completely illustrate what takes place.

The first of the curves shows the performance of a better quality output transformer popular a few years ago when connected into the 17-watt amplifier.

Curve 1 shows the response of the amplifier without feedback and speaks for itself. Roll-off commences below 10 Kc and continues steadily thereafter. No resonances are shown on the curve, mainly because the response has fallen so far below reference at frequencies concerned that the are well off the bottom of the graph. The square wave obtained at this time shows the effect of falling high frequency response by its rounded corners, but it also shows some ripples on the contour which are caused by the resonances being excited with the high frequency components of the square wave. Oscillation and ringing can scarcely occur under these conditions.

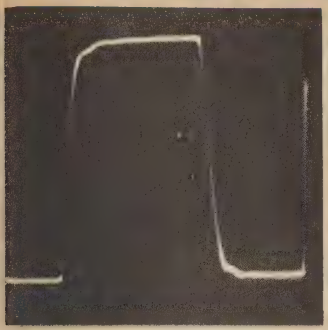
The second curve on the graph shows what has happened when 20 db of feedback is applied to the amplifier from the voice coil to the input stage.

RESONANCE PEAKS

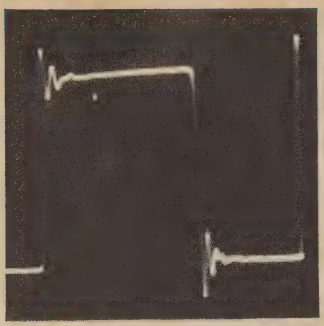
There is a high resonance peak at approximately 120 Kc, a smaller one at 200 Kc and a third at about 75 Kc.

You will notice that, although only 20 db of feedback has been applied, these peaks have risen by much more than this amount. This is because of the regeneration which has taken place in the vicinity of the peak frequencies due to positive-going phase changes in the amplifier, and it is obvious that, with still more feedback, oscillation at the major peak frequency would eventually take

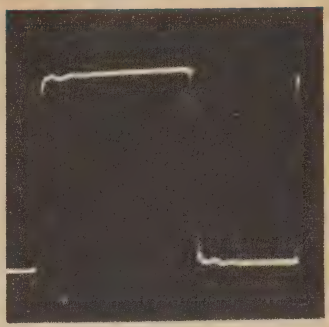
SQUARE WAVE RESPONSE OF PENTODE AMPLIFIER



A 5 Kc square-wave trace of the pentode amplifier without feedback as referred to in this article.



The same amplifier with 20 db of feedback shows pronounced ringing and overshoot.



A capacitor connected across the feedback resistor has materially reduced the ringing and improved stability.

place, although it was not present at this time.

An inspection of the square wave which matches this curve shows just what we would expect—appreciable ringing and overshoot at the high amplitude frequency sufficiently well marked almost to swamp further ringing effects at the other two frequencies, which make their presence known by the irregularities in ringing which appear further along the trace.

By selecting an appropriate value of capacitor across the feedback resistor, we produce curve 3. The drastic modification to the response curve mentioned last month by the addition of this capacitor is clearly shown here, for it has almost wiped the effect of the major peak, and the one above it. There is still a discontinuity in the curve round about 80 Kc, and we would expect to find some evidence of this in the square wave pattern.

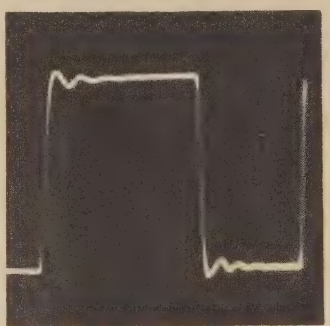
And so we do, the lowered ferquency of the small amount of ringing showing quite clearly on the top of the trace. Testing the amplifier with extra feedback and load capacitance demonstrated, too, that its stability had substantially improved.

The final treatment was to introduce a step circuit at the plate of the first valve, the values being somewhat similar to those used in the circuit given last month. The capacitance value selected was that which gave the greatest stability, and in fact the amplifier now would not oscillate with any added capacitance across the load, although values in the vicinity of .05 mfds were the most critical.

EFFECT OF CAPACITANCE

With this capacitance added, the frequency response revealed a very large peak round about 100 Kc, indicating that it had modified the effect of the feedback capacitor to such an extent that the effect of the large resonant peak was once more significant.

The frequency response of the amplifier with the step circuit is shown in curve 4, and it will be seen that the steeper roll-off has accentuated the previous disconuity at about 80 Kc, so that we could expect to find increased ringing at this frequency. The photograph of the square wave trace confirms this, and reference to the previous trace



Addition of a step circuit has accentuated ringing but has further increased stability.

shows that the ringing frequencies in both cases is substantially at the same frequency.

This final adjustment is probably the best that can be done with this amplifier, for the amount of ringing is not severe, although more than one would like, and it is reasonably well damped.

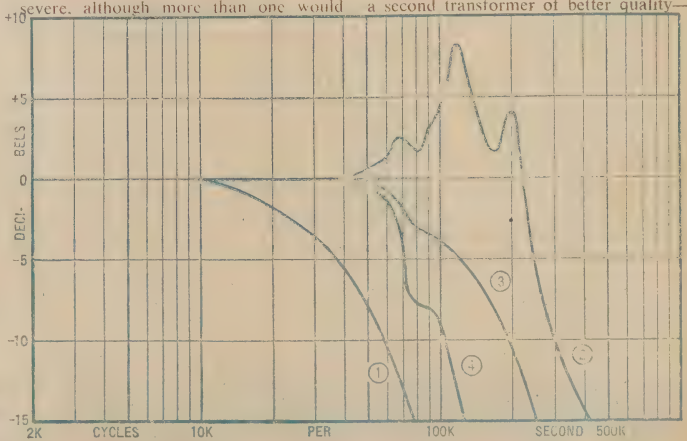
It is obvious that to continue the roll-off process to remove it would mean the attenuation of the upper register sufficiently to reduce the gain at about 80 Kc quite severely, and, this could only be accomplished by extending the commencement of roll-off down into the audible range.

The amplifier would still sound quite well, but its specifications could not be considered as being in the upper class.

LIMITED FEEDBACK

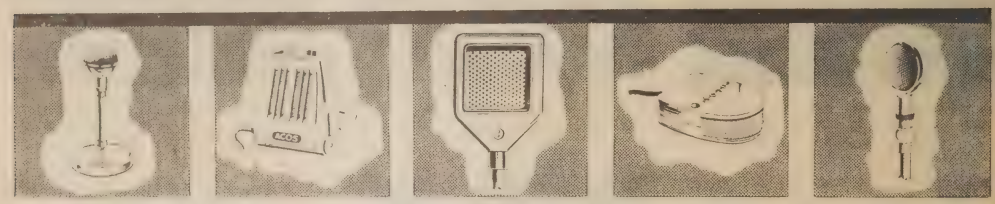
This particular transformer was selected simply because its performance pattern is a particularly clear one. We have used others which exhibited virtually a single resonance peak as low as 50 Kc and of much higher amplitude. It is clear that, with such a transformer, only a limited amount of feedback could be used without danger of oscillation, and that, if the amplifier was adjusted to remove its effects, the final response curve would be far from good, particularly in its response to transients. A rounded corner on the trace would be inevitable.

By contrast, the second curve shows a second transformer of better quality—



A series of response curves taken from the pentode amplifier referred to and for which square-wave traces are shown above.

★ CRYSTAL MICROPHONES
★ MICROPHONE INSERTS



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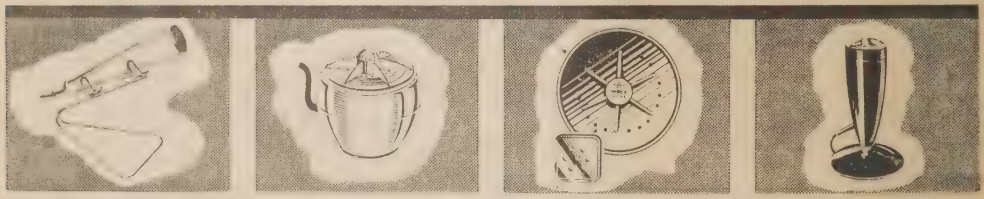

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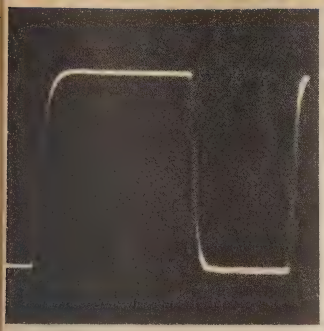
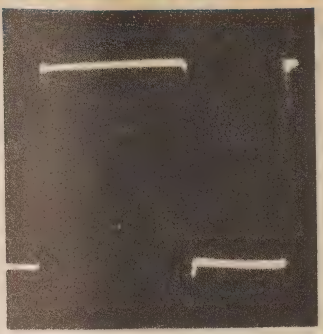
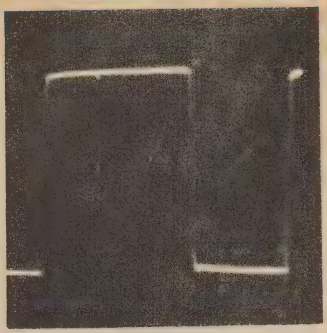
SQUARE WAVE RESPONSE OF 17-WATT AMPLIFIER



Square-wave response ot the 17-watt ultra-linear amplifier without feedback indicates a good performance.



Application of 20 db of feedback has produced a very small amount of overshoot and no appreciable ringing.



A capacitor across the feedback resistor has virtually removed all traces of abnormality from the square-wave pattern.

an ultra-linear type connected to the same amplifier.

Curve 1 shows its response without feedback, and it is at once obvious that results are going to be noticeably better.

The response is flat to just beyond 20 Kc and a smooth roll-off continues after that point.

The oscillograph trace for this curve shows a rounded front corner, but only on the bottom cycle is there any trace of resonances. This would indicate that resonance frequencies will be high, their amplitude lower than for the first transformer, and that there is a small unbalance which will show them at slightly greater amplitude on the downward stroke of the waveform.

The application of 20 db of feedback bears out this forecast. The curve number 2 shows a main resonance of 200 Kc of appreciably lower amplitude than for the first transformer, with two smaller resonances, one at 100 Kc and another at about 130 Kc. The upper range of the curve crosses reference on its final descent at about 430 Kc. and is only a 4 db down at 500 Kc.

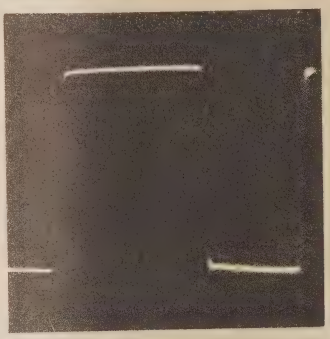
Reference to the square wave pattern shows very slight ringing and overshoot at the commencement of the flat top, with almost immediate damping. As predicted, the overshoot is greatest at the bottom, indicating a small unbalance. probably the reason why it is not so noticeable at the top corner.

COULD BE UNSTABLE

We would expect this condition to be stable in ordinary use, but susceptible to oscillation with critical capacitances across the load.

The third curve shows modification of the response with a capacitor of 50 pf across the feedback resistor. This small value has suppressed the main peak by about 8 db and smoothed out the effect of the others. It appears that the capacitor value is somewhat below optimum. No oscillogram was taken for this curve.

Curve number 4 was taken with the feedback capacitor increased to 100 pf. This has smoothed the lower frequency peaks almost completely out so that they are difficult to trace by the response curve, and reduced the main peak to a notch at 200 Kc. We would, therefore, expect to find a very small residue of the over-shoot pip we saw on the previous oscillogram, and an otherwise clean flat top. for the curve is substantially smooth up to this point.



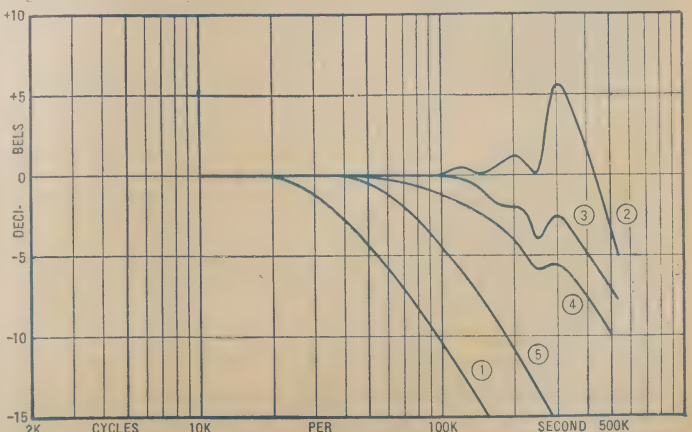
A step circuit has increased stability and had little effect on ringing, only just discernible at the bottom corner.

Reference to the oscillogram once again bears out anticipations. The overshoot has virtually disappeared from the top of the trace, and can only just be discerned at the bottom, where it has always been most apparent.

The final curve was taken with the step circuit added to the plate of the first valve The attentuation it represents was enough to reduce the slope of the roll-off to about 6 db per octave, and to remove the final discontinuity to a point where only the most scrupulous plotting of a curve could reveal it. Its minor nature is illustrated by reference to the final oscillograph, where a very slight increase in overshoot can be detected at the bottom of the trace.

GOOD STABILITY

In ordinary use, the amplifier was perfectly stable at this point, and could only be induced to show some ringing and oscillation over a narrow band when a critical capacitance of about .03 mfds was connected across the load. This connection introduced a peak in the response curve at about 200 Kc where it might be expected, but as such a capacitance is not found in any other type of load, it is of no significance in practice. As shown in the oscillograms in last



These curves show the frequency response ot the ultra-linear amplifier as detailed on this page.

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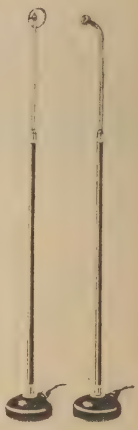

Technical Data:

Frequency response 30-15,000 cycles ● Output impedance 200 opms. ● Sensitvity 0.08 mv/ub ● Maximum deviation of response 50-8000 cycles 3db ● Dimensions of base 170 mm., 60 mm. high ● Dimensions of tube 900/1500 mm. long ● Weight 1.5 kg approx.

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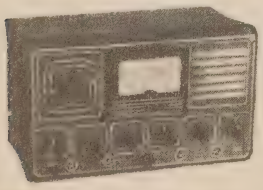

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month's article, the square wave characteristics were virtually unaltered whether the load was 2 or 15 ohms resistive, a loud speaker of 15 ohms, or a cross-over network intended for three-speaker operation.

Only with certain values of deliberately added capacitance could any ringing be introduced to the trace.

The improvement to the performance of the amplifier, therefore, by the use of a high quality transformer in which resonances are controlled far into the supersonic region is clearly demonstrated by a comparison between these two transformers.

EXTRA FEEDBACK

The addition of extra feedback did not alter the general high frequency characteristics to any noticeable degree, even when it was increased to over 30 db, nor did this have any effect on its stability in this region on any kind of working load.

It does not necessarily follow that such a severe test could be successfully applied to the amplifier with other transformers having less desirable characteristics, however, such as might be the case in the ordinary course of home-building.

As mentioned in last month's article, we have for the purposes of this analysis ignored the effect of circuitry on the high frequency performance of amplifiers because of the major part played by the output transformers. It is quite true that, in the extreme upper frequencies we have been considering, circuit capacitance will have some effect. Valves capacitances, the characteristics of various types of phase-changer and so on will modify the results to some degree, and these will be of interest to the specialist designer.

But providing that combinations of good quality are used, they are not likely to seriously modify the general pattern of results as exposed in these experiments.

And with the feedback restricted to 20 or 22 db with all the standard transformers we could collect as being suitable for the amplifier, the stability margin could be considered as more than adequate.

As a matter of interest, an oscillogram showing the overload characteristics of the amplifier at 5 Kc is included. It illustrates the good balance of the amplifier, its linearity up to the clipping point, and the sharp cut-off characteristic of a well-designed circuit with feedback. Because the distortion at overload is obviously severe and sudden, it is good practice to use an amplifier with ample output power so that the overload point it not reached, even on the steepest transients.

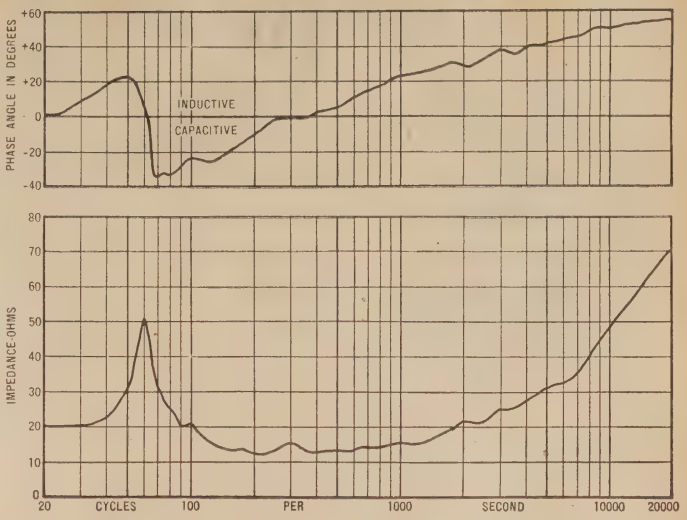
SPEAKER LOADS

The curves shown on this page, and which were taken from a book by G. A. Briggs on loudspeakers which has just been published, show that the load presented to the amplifier by either a loudspeaker or a cross-over network do not resemble a pure capacitance in the range between about .02 and .5 mfds, which we have seen is likely to be a critical condition for amplifiers.

At no time in fact does the phase angle curve approach 90 degrees in either direction, which would be necessary for the load to become purely capacitive or inductive.

This is borne out by the square wave oscillographs for different types of loads

PERFORMANCE CURVES OF SPEAKERS



This diagram, taken from "Loudspeakers" by G. A. Briggs, shows the phase angle and impedance curves for a 10in loudspeaker mounted in a 2 cubic ft. reflex enclosure with acoustic filter. At 45 cycles the system is equivalent to a 24-ohm resistor in series with a 33mH inductor.

shown in last month's articles, and referred to earlier in this one, which show no sign of critical reactance effects.

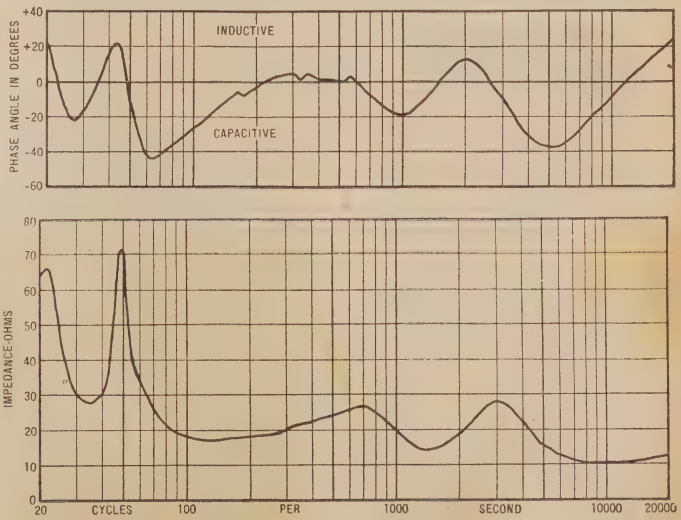
The presence of a resistance or resistive component in series with a load capacitance is most significant in determining its effect on stability.

Even with an added critical capacitance, the presence of a few ohms series resistance will reduce ringing and prevent oscillation.

The curves show that a well-adjusted cross-over network is likely to be more stable than a single speaker, as it resembles much more closely the ideal of a constant resistive load.

The curve actually crosses the zero line in eight places throughout the range.

This is borne out by our own experience during these experiments, which in-



These curves show the behaviour of a 3-speaker reflex system with cross-over network. The load is most predominantly resistive—the curve crosses the zero line in eight places. Note the impedance curve which is almost flat above 60 cycles.

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icated stability under critical conditions ery little inferior to that of a pure esistance.

Instability in the frequency range rom about 30 cycles to 10 or 20 c does not normally occur in ampli- ers, because any design worthy of the ame has a fairly flat response in that egion, and the input and feedback volt- ges will remain substantially in correct hase.

But there are several factors which an contribute to low frequency instabil- y, or motor-boating, as it is popularly alled.

A full treatment of amplifier be iviour ith feedback can become quite involved, s illustrated by the vast amount of tech- ical writing on the subject. What appens may be summarised as follows:

PHASE CHANGES

As far as the output transformer is oncerned, there are no resonance peaks imilar to those which occur in the igh frequency region, but at frequencies ow enough for the various reactive com- onents in the amplifier to cause phase hanges, oscillation due to positive feed- ack becomes possible, and instability an result.

These phase changes occur in the out- ut transformer itself at frequencies here the inductance of the windings is ot adequate to maintain constant am- lification.

They will also occur due to the pres- nce of coupling and bypass capacitors at requencies where the reactance of these omponents becomes an appreciable umber of ohms.

The power supply, which is common o all circuits, will also be responsible or phase changes at extremely low fre- uencies, for even the largest filter ca- acitors will have reactance values equal o hundreds of ohms at frequencies ap- roaching zero.

The net result is that, particularly hen feedback is applied, the amplifier requency response will exhibit a peak n the region of a few cycles per second, nd this peak is to be seen in all such urves which have been published from me to time. It is the result of cumu- ative regeneration, and while its presence oes not automatically indicate instabil- y, oscillation is almost inevitable if the egree of feedback is sufficient.

It is not easy to illustrate amplifier erformance at low frequencies by urves and oscillograms, for the equip- ent needed must be capable of operat- ng efficiently down to zero frequency, nd is not normally found outside the aboratory.

CIRCUIT TREATMENT

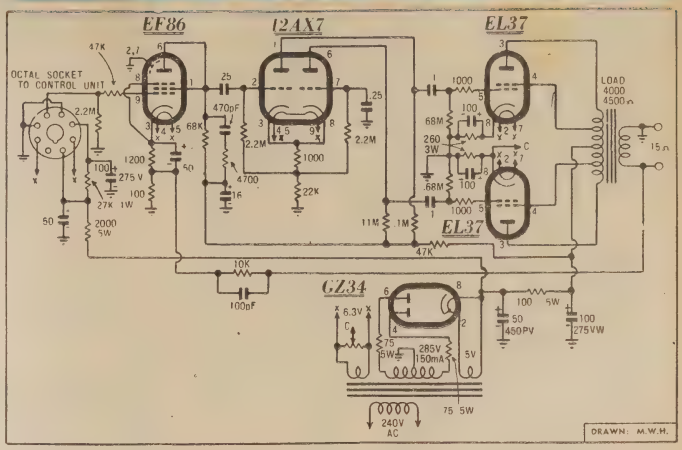
But if the fundamentals of the mat- er are borne in mind, it is possible to lemonstrate various treatments and to bserve their effect on a given design.

In practical cases, these treatments ivide into two main categories—those oncerned with low frequency response n the various stages, and those con- erned with power supply coupling.

With optimum circuit values and good ransformers, low frequency instability is ot usually a problem with 20 db of eedback. This has been demonstrated vith the 17-watt amplifier using the cir- uit values as published.

By restricting feedback to this figure, oupling and bypass capacitors and even utput circuit balance are not particular- y critical and the design is thereby sim- plified.

VERY HIGH STABILITY CIRCUIT



The 17-watt circuit showing addition of a step circuit and larger capacitors. Neither is essential for complete stability on any type of normal load, even with long speaker leads.

If the feedback is increased to amounts more than about 26db, however, more care will probably be required, and some designs show evidence of this.

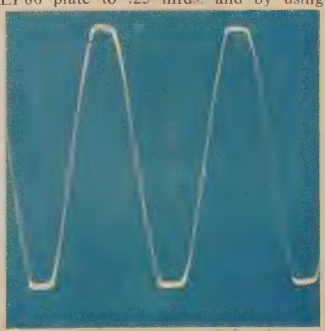
One method of reducing amplifier phase shift at low frequencies is to stagger the roll-off characteristics of the various stages in order to reduce the steepness of the final portion of the attenuation, for steep attenuation means rapid phase shift. This is generally accomplished by reducing the coupling capacitor between the first valve and the phase changer, for instance, and selecting the values of cathode bypass capacitors.

LARGE VALUES

With most transformers available at the present time, however, and this is probably true of all but special types, best result will generally be obtained by using the largest practicable capacitance values, so that their roll-off commences below the natural roll-off point of the transformer.

This was illustrated by increasing the feedback on the 17-watt amplifier until motorboating at a very low frequency could just be induced.

Stability was restored by increasing the value of the coupling capacitor from the EF86 plate to .25 mfds. and by using the same value for the capacitor which earths the grid of the phase-changer. No improvement was noticed by increasing the coupling capacitor values in the grid circuits of the output valves.



Overload characteristics of the 17-watt amplifier at 5 Kc.

If such high feedback were to be considered, it is probable that balancing the output valves for plate current and input voltages would effect still further improvement, as such severe operating conditions would involve the regulation of the power supply. Separate bias circuits for these valves would also be advisable, as the balancing of this stage becomes progressively important as the stability margin is reduced.

Even without these additional changes, it was possible to apply a sudden switching transient sufficiently large to momentarily paralyse the amplifier, and to see it return to normal operation after two or three cycles of slow oscillation.

With the normal feedback of 20-22 db however, no instability of any kind could be produced.

DIRECT COUPLING

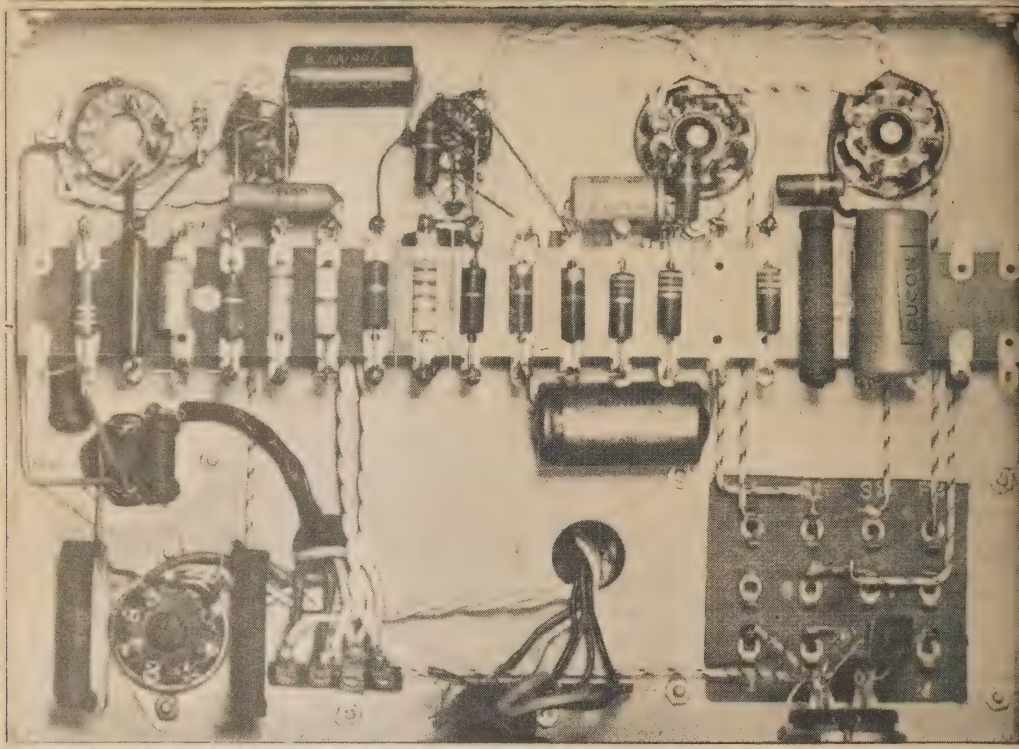
With the aim of reducing one source of amplifier phase change, some circuits use direct coupling between the first valve and the phase changer, but because the stages are still coupled appreciably through the power supply at frequencies of a few cycles per second, this is not as successful as might appear at first sight. It has the disadvantage of reducing the effective voltage applied to the valves concerned, and thus limiting their voltage output which, in the case of the phase changer at least, could be an important point.

Because the power supply is one portion of the amplifier which is common to all circuits, and in most cases to the control unit as well, special consideration must be paid to it.

Best stability will be obtained when the total impedance of the supply is kept as low as possible, which means the reduction of common DC resistance and the use of high-value filter capacitors.

In the 17-watt amplifier, a 100 resistance is used in place of the original filter

UNDER-CHASSIS VIEW SHOWS USE OF COMPONENT STRIP



Under-chassis photograph of the 17-watt amplifier showing the use of a component board. Twin 50 and 100 mfd electrolytics are used, but single tubular units could be substituted. The input socket is at top left.

choke which had a resistance of several hundred ohms, and a total of 150 mfds smoothing capacitance. The rectifier is of a low-resistance type, to reduce this form of coupling to a minimum.

A very considerable increase in stability results from feeding the control unit high tension directly from the rectifier, so that the main resistance-capacitance filter is not included in its feed circuit. Two resistors and 150 mfds of capacitance serve to isolate the control unit still further from possible variations in the amplifier power supply, and this procedure provides stability equal to that achieved by using a separate power supply for the control unit.

With any of the control units described for the Playmaster amplifiers, it is possible to set the gain control and extra bass boost control to their respective maximums, and to feed any kind of signal into the unit up to overload point with no evidence at all of low frequenc instability.

Feedback can be increased very ap preciably with the controls set in thi unrealistic position with the same resul

So far in this discussion of amplifie response we have considered the type o waveform which goes in and compare it with what comes out, with no refer ence to the waveform which passe through the amplifier from stage to stage It is obvious that, if the output wave

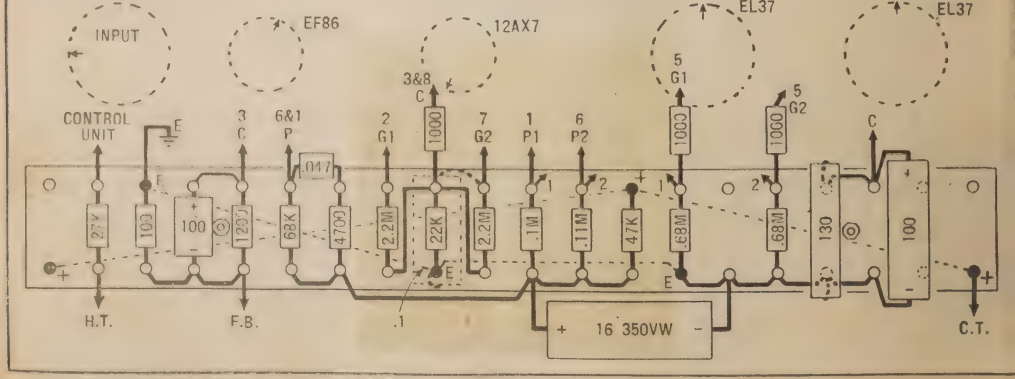
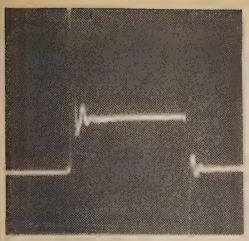
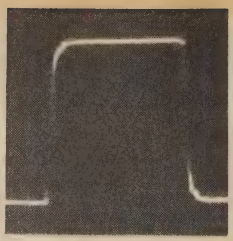


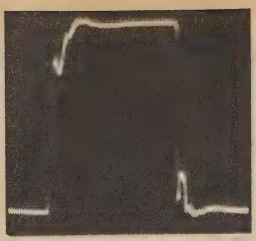
Diagram showing the placement of components on the instrument board



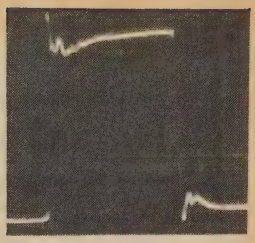
Waveform at plate of EF86. Note large spikes caused by regeneration at transformer resonance.



Waveform at EF86 cathode has notches at corners indicating reduced feedback at resonant frequency.



Waveform at plate of first 12AX7 shows pattern largely reciprocal of that at EF86 plate.



Waveform at plate of second 12AX7 shows the effect of phase reversal in the phase changer.

form is virtually identical with that found at the input, and if we know that the fundamental response of the amplifier is replete with peaks and phase changes, there will be a procession of complimentary but distorted waveforms within the amplifier.

It is interesting to note what these might be, and whether there are any dangers inherent in their presence.

Shown on this page are a procession of waveform photographs obtained by feeding a 5 Kc square wave into the amplifier and connecting the oscilloscope to various points. In order to show the various effects more clearly, a version of the 17-watt amplifier was denuded of all compensation circuits, and operated with 20 db of feedback.

The first trace was taken from the plate of the EF86. The interesting thing to note here is the very high spike at the commencement of the trace.

This spike represents the frequency of the main transformer resonance at about 100 Kc as revealed in the response curve shown on page 33. By increasing the frequency of the oscillator, this frequency was found to be the one which lined up with the spike.

CROSS CHECK

A further check was made by observing the frequency response of the amplifier as read at this check point, and a very large peak was observed in the response at that point.

It is obvious that, if program were to be fed to the amplifier with components which could excite it at this frequency, the phase-changer would be in danger of overload at higher levels.

In practice this is not likely to occur, as input voltages of sufficient amplitude at this frequency would be most unusual. But it is a most significant point in understanding the operation of an amplifier, and underlines the dangerous effects of regeneration at these peak frequencies. In this case, the amplifier could probably be shocked into oscillation if the feedback were slightly increased.

The next waveform shows the waveform as read at the EF86 cathode. The sharp notch on the leading corner is what we would expect to see with a decrease in negative feedback in this region, and this is what happens through the presence of the transformer peak. This waveform is not purely a representation of the feedback voltage—it is modified by the operation of the EF86 —but the pattern is there.

AT THE PHASE-CHANGER

The third trace is taken at the plate circuit of the first 12AX7 section. It is to a large extent a reciprocal of the trace at the EF86 plate, for it has undergone a phase change through the triode, and instead of spikes on the leading edge we find complementary notches in the pattern. Note again that the trace is not symmetrical, indicating unbalance in the output transformer which initiates the voltages which are modifying the original square wave.

The fourth trace is taken at the plate of the second 12AX7 section. Here a further phase change has taken place, so that we see a modified form of the trace at the EF86 plate.

The spikes here are very much reduced in amplitude. This could be due to a clipping action of the valve sections as we would expect if the input was high enough to overload them, but more probably because of the falling frequency response of this part of the circuit at the 100 Kc frequency. Note again that the balance is not perfect.

The next two traces were taken at the plates of the output valves and here we see the general shape of the two wave-forms which, combined in the output circuit, make up the wave-form as seen by the loudspeaker. Again it will be noticed that there is an unbalance between the two sides of the circuit and their imperfect cancellation might be expected to leave some ringing pattern in the output. This is confirmed by the next trace which shows a small amount of unbalanced ringing. It was taken from the output terminals of the amplifier.

Both these wave-forms are affected by the close connection of the valves to the transformer, and to each other through the transformer. Thus they are not completely representational of the contribution each valve makes individually to the circuit.

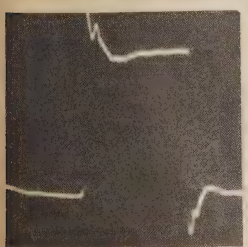
As a matter of interest, compensation was restored to the amplifier, and the last two traces photographed. The first shows the EF86 plate circuit again, with the spikes very much modified, due to the suppression of the resonance effects in the transformer. The second is the trace at the output terminals, again showing a considerable cleaner, and quite good wave-form.

DISTORTION DANGER

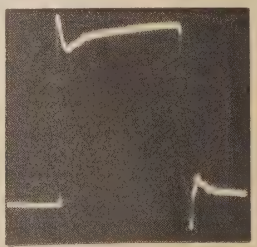
Some of these wave-forms show malformation of the flat top extending almost halfway along it, and would, therefore, concern frequencies quite close to the top of the useful audio range. It could be argued that intermodulation products might be expected if resulting non-linear effects were to fall within the band, or if bias shifts were to take place at high amplitudes which could originate such distortions.

At any rate, it is clear, as emerged from earlier discussions, that transformers with very high frequency peaks of low amplitude which can be nullified

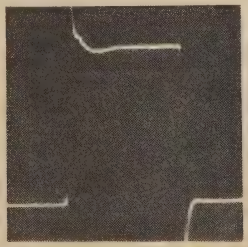
(Continued on Page 127)



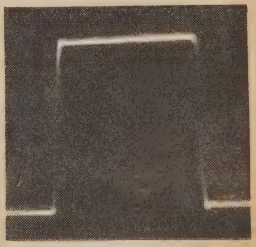
Waveform at plate of one EL37 output valve.



Waveform at plate of second EL37.



Waveform at plate of circuit of EF86 with compensation.



Waveform at output of amplifier with compensation.

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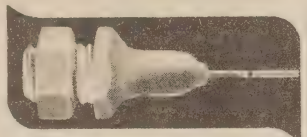

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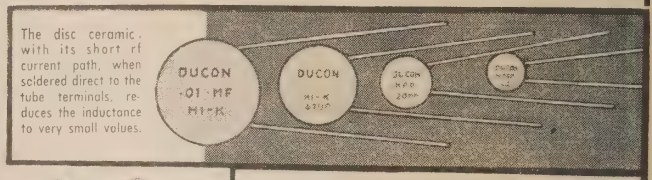
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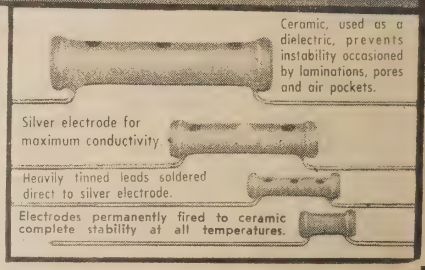
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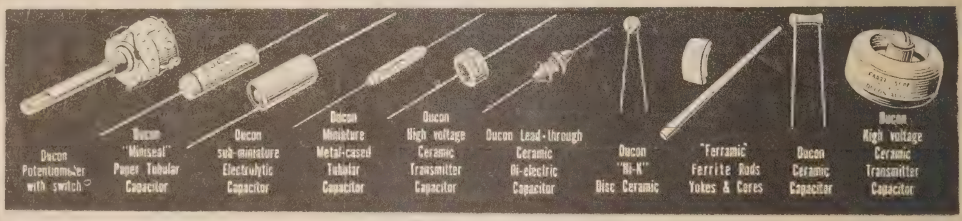
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"Ferramic" Ferrite Rods Yokes & Cores
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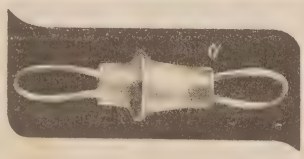
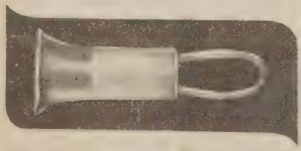


TYPE CAC—Feed-thru flange mounting type can be soldered direct to the chassis or shield plate in tuner units. From 50 pf. min. to 1500 pf. max.



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FROM THE SERVICEMAN WHO TELLS

It is sometimes difficult to decide which aspect of servicing provides the greatest interest; the receivers one is called upon to repair or the people who own them. Two stories I have to tell this month demonstrate this quite forcibly, showing exactly opposite reactions to typical set failures.

YEARS of experience have taught me that a fair percentage of the public will tolerate the most atrocious performance from a radio, just so long as it continues to go at all. It is only when it fails completely, or smoke pours forth, or they get a shock from the chassis, that they call on the serviceman.

I have been watching TV owners with keen interest to see whether they would exhibit similar characteristics. Would they be happy with any image that moved, no matter how degraded, or would the high cost of their equipment and greater impact of vision make them ultra-critical, demanding that every little ghost, streak or blotch be fixed immediately?

I'm afraid my observations are somewhat inconclusive, since I have not yet sampled what might be considered a reasonable cross-section of the community, but the case I am about to relate is certainly one to be filed under the heading: "How indifferent can you be?"

The story started out as a fairly routine type of call. The owner reported simply "no picture," and I was able to establish that there was also no raster of any kind. Failure of the EHT is the most usual trouble in such cases, though the actual fault may be any one of a wide variety.

OBVIOUS FAULT

A preliminary check in the customer's home confirmed the lack of EHT, and one look inside the cage was enough to show the reason. On one side of the EHT winding there was an ominous black spot about the size of a match-head, with the protective wax melted away from it on all sides. Very obviously the EHT transformer had "had it."

However, this was not all. In fact, the first thing that had struck me on switching on was a very severe distortion of the sound, together with apparent lack of sensitivity. I mentioned this to the owner, and he agreed that he had noticed this, but I gained the impression he could hardly have cared less about it.

"It doesn't worry us very much," he said. "After about 10 minutes it gives a bit of a click, then the sound gets louder, and it's pretty right for the rest of the night. Only thing I don't like is having to get up to turn it down when it clicks. It might help if you can fix it." (This last more in the nature of an afterthought.)

Not knowing the exact nature of the sound fault, and considering that replacing the EHT transformer was a fairly complex job anyway, I decided to take the chassis back to the shop. After all, there is a limit to what can be done conveniently in the customer's home.

Back at the shop I set about fitting the new EHT transformer, being one of those tedious jobs where all the components seem to be just that much too big and all the available space just that much too small. However, it was eventually completed, and the picture restored to its former brightness.

Then I turned my attention to the sound. It was still horribly distorted, and I was thinking in terms of intermittient ratio detectors, etc., as I turned the chassis on its side for a more detailed examination. In any case, I was hoping that the trouble would persist long enough for me to get a lead on it before it came good, as the owner had prophesied.

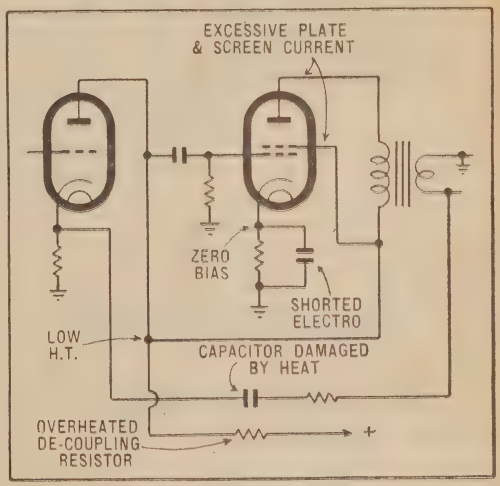

Diagram showing the faults found in the first receiver dealt with this month.

I need not have worried. Immediately I was able to inspect the underside properly I was confronted with obvious evidence of trouble. A wire-wound resistor, five-watt size, had changed from its customary black to the dull white of the ceramic former. It had obviously suffered a pretty severe overload.

OUCH!

I made a tentative jab at it with the tip of one finger and, even with such a fleeting contact, brought forth an involuntary exclamation—a rather rude one I'm afraid. Whatever the trouble was, it was making that resistor sizzling hot. For the next few minutes I rather wished I had been more cautious.

Switching off, I examined the circuit more closely. The resistor was a decoupling unit in the main HT supply to the audio amplifier, suggesting that either the associated electrolytic was leaky or that the output pentode was operating under some abnormal condition such that it was drawing excessive current.

I measured the HT on the amplifier side of the resistor and this turned out to be only about half what it should have been. Before taking the trouble to lift the electrolytic from the circuit, I checked the bias voltage across the output cathode resistor—a very useful measurement since it can reveal so much about the behaviour of the output stage.

In this case it was more helpful than usual, for the simple reason that it was virtually non-existent. In the circumstances, it was not surprising that the output valve was drawing more than its fair share of current, or that the signals were weak and distorted.

Almost automatically, I disconnected the 25 mfd electrolytic from across the bias resistor, then tried again. As I expected, the bias was now normal, while a new electrolytic completed the cure as far as the actual sound was concerned.

But the job was by no means finished. There were three components still to be checked and possibly replaced: the decoupling resistor, the output valve and a capacitor which had been close alongside the overheated resistor and which had suffered at least some physical distortion as a result.

There was really little doubt about the resistor. Even though it was still intact electrically, it was in poor shape physically. Considering the relatively small amount it would add to the bill, I had no hesitation in replacing it.

Much the same applied to the capacitor. This was associated with the negative feedback network and which also appeared to be intact electrically. However, the moulded case had almost com-

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pletely melted and was now draped over the "works" in the manner of an overcoat about three sizes too large for its owner. This was also replaced.

Strangely enough, the valve seemed to have suffered least from the ordeal. It showed "good" in the tester, as well as behaving normally and drawing normal current in the set. Since it happened that the set was only a few months old, anyway, I could see no logical reason why it needed to be replaced. Even assuming that its life expectancy had been reduced by a few months, it probably would still be going in a couple of years' time. At least, I could save the owner that much.

ELECTROLYTIC PUZZLE

As a matter of interest, I also tried the ohmmeter across the discarded 25 mfd electrolytic, expecting to find a dead short. Instead, I could find no evidence of leakage in any degree, the "resistance" comparing favourably with that of a new one. While this is, admittedly, only a rough test, it usually gives a fairly good indication of any abnormal condition.

I can only assume that the capacitor broke down only when the normal operating voltage of the stage was applied and, most particularly, after it had been standing with no voltage applied for several hours. On the other hand, it seems that the application of voltage for 10 minutes or so was sufficient to clear the fault; and to clear it quite positively and virtually instantaneously. Perhaps the capacitor manufacturers could explain the reason, otherwise I must simply accept it as "one of those things."

The owner was rather surprised to learn that the faulty sound which he had so lightly discounted had involved so many components, plus the possibility of even greater damage had it been allowed to continue.

I also took the trouble to point out something which many people seem to overlook until it happens. There is nothing more frustrating than a TV set which goes on the blink in the middle of your favourite program. Whether it be drama, comedy, or plain who-done-it, one is left up in the air with one's curiosity aroused, and no means of satisfying it.

INTOLERABLE

The very fact that TV is such a compelling medium and able to hold its audience to such good effect makes it inevitable that such failures will be accepted less tolerantly (at least sub-consciously) than would be the case with radio, or even the cinema. After all, in the latter case, the presentation is normally restored and one is seldom robbed of any significant portion of the story.

While some such failures are inevitable, the owner who draws his serviceman's attention to obvious defects before they have had time to develop into something more serious will at least avoid those which are avoidable.

By contrast, my second story might well be entitled, "How worried can you get?" since it serves to illustrate the exact opposite reaction to the first sign of trouble.

This is not one of my own case histories, but rather an incident which happened to a colleague, and which was related to me by him. I have no doubt that it is a perfectly accurate account of what happened, as you will doubtless agree when you have heard it.

My friend is not a professional serviceman, but has been in the radio game practically all his life. He built the TV set concerned in this story, the 17-inch model described in the May, 1957, issue, and is well clued up on what makes the various parts tick.

The story started when he arrived home late one evening and found the family in a state of mild panic. Explanations varied from the bald statement that the TV set had "blown up" (this from his wife) to a more detailed description from his son. From the latter he gathered that there had been a bright light from inside the cabinet, a spitting sound, a smell of burning, . . . "then the picture seemed to get a bit smaller and suddenly went off completely." He added that he had switched it off immediately.

My friend was hardly in the mood for tracking down TV faults at that late hour, but he couldn't resist a glance inside the back of the cabinet. There wasn't much to see, but his nose told him plenty. One sniff and he registered: "Power transformer gone up."

This wasn't a very pleasant thought, for such items are costly, as well as making just one more job to have to fit into his already limited quota of spare time. In the circumstances he felt he couldn't rest until he had settled the point one way or the other.

PRELIMINARY CHECK

Removing the rectifier, he switched on somewhat gingerly and stood by to switch off again in the event of fireworks. There were none of these, but he was rather horrified at the speed with which the filaments lit up and the brightness they reached. Something seemed obviously to be wrong and the prospect of doing in—or having done in— a whole set of filaments—including the picture tube—was more than a little frightening. Very hastily he switched off.

By now he was beginning to build up some kind of picture of what had happened. It seemed certain that the power transformer had failed in some respect, and it looked as though this was most likely a short across a section of the primary winding. This would upset the turns ratio and cause the secondary voltage to increase in direct proportion. Hence the over-bright filaments.

Somewhere along the line the extra HT volts had caused an electrolytic to break down, which would have accounted for the spitting sound and disappearance of the picture.

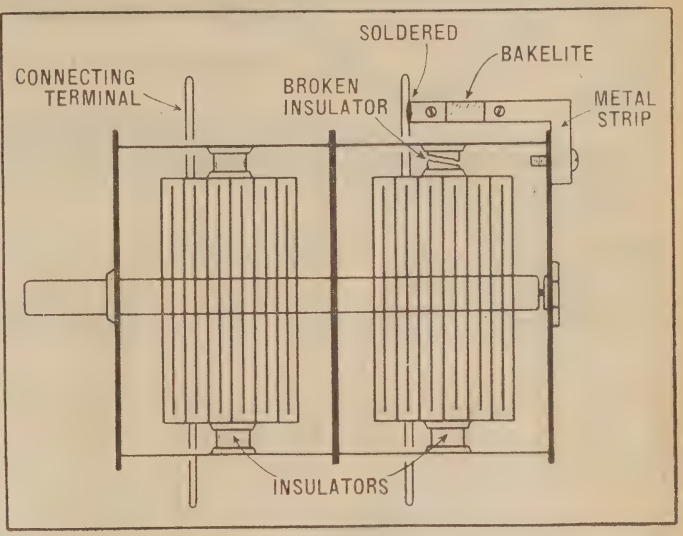
Disturbing questions began to race through his mind. By how much were the filaments being overloaded and how long had this condition existed before the final blow-up? How many cathodes had possibly been ruined and was the precious picture tube among them?

Any ideas he might previously have entertained about going to bed had now vanished. Sleep would be impossible with all these possibilities before him, so there was nothing for it but to pull the chassis out and find out just how bad things were.

With the chassis on the bench he gave it a quick visual examination, particularly around the power transformer, but could see nothing obvious which might account for the trouble. Not wishing to subject the picture tube to any more abuse he removed the base and yoke sockets, a procedure which also removed the HT supply from the cage by reason of the safety link.

Then, with the rectifier removed and a meter across the filament line, he gingerly switched on for the second time. He fully expected the pointer to swing well up the scale past the 6.3 volt mark, and was all set to switch off again as soon as the approximate value had been established.

Imagine his surprise, therefore, when the pointer settled itself almost exactly on 6.3 volts. This was indeed a shattering blow to his carefully worked-out



Acoustic feedback was caused by a broken insulator in the oscillator section of this tuning capacitor.

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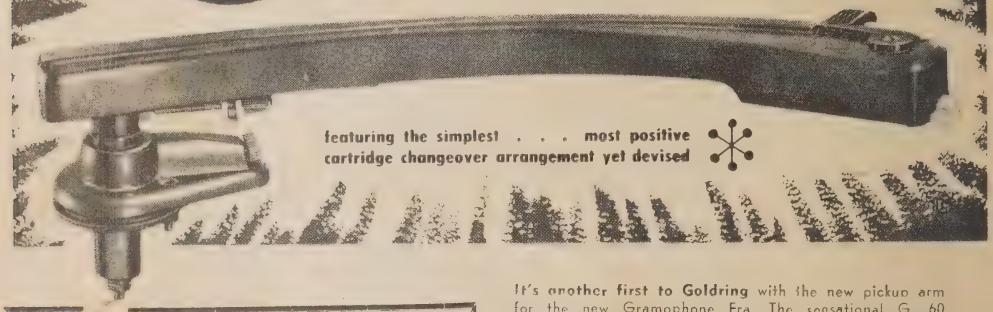

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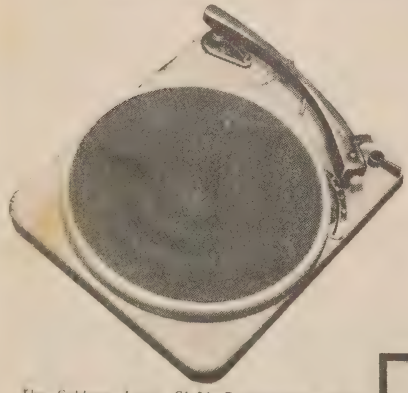

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MERRY XMAS

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theory: but a welcome one, nevertheless. At least there was now no immediate hurry, and he left the set running like this for several minutes. During this time the voltage remained steady, and the transformer showed no sign of overheating.

Thus encouraged he plugged in the rectifier, though still with one hand on the power switch. All that happened was that the sound from the appropriate channel came through loud and clear. There was no sign of distress in any form.

At this point my friend was beginning to doubt the powers of observation of both himself and his family. Was there really something wrong with the set, or had some other effect, such as a station failure, caused his family to panic unnecessarily? And for that matter, what about his own observations; the over-bright filaments and the smell of burnt power transformer. Where did they fit in?

TROUBLE—AT LAST!

Considerably puzzled, he plugged in the picture tube and switched on again. This time things began to happen as soon as the valves warmed up. There was a burst of violent spluttering from the general direction of the cage, and the smell of burning bakelite.

My friend switched off almost automatically at the first splutter but then, realising that the trouble had to be found somehow, he switched on again with rather more determination.

In fact, it took only a few seconds to track it down when it started the second time, the sense of sight and hearing leading straight to the deflection yoke plug and socket combination. Closer examination showed it to be a perfectly ordinary flash-over between the two pins.

It was a horrible let-down, and my friend was temporarily uncertain whether to be happy that it was of so little consequence, or annoyed that he had allowed himself to be led on such a wild goose chase. Eventually, of course, common sense prevailed.

Later, when he told me this story, he was able to explain how it was he had been led astray. The main factor was probably the strange coincidence that caused the burnt plug to smell like burnt power transformer; and it must have been a coincidence, because there is normally nothing that smells quite like burnt power transformers.

IDEA TOOK COMMAND

Once this idea had established itself, it more or less took command, and all other happenings were viewed in the light of this possibility. By a strange coincidence, it was possible to make them fit this theory, even though it was a completely false one.

Thus, when it was noticed that the filaments appeared to be over-bright, this fact was immediately associated with the transformer failure, and the two ideas combined to suggest a shorted primary section. Further weight was added to this theory when it was remembered that the picture was reported to have shrunk somewhat before it failed, an effect which could conceivably have been due to excessive EHT.

In fact, this latter effect was almost certainly due to the momentary leakage which occurred just before the actual flash-over. The fact that it was probably only a horizontal shrinkage was easily overlooked by all concerned.

As for the over-bright filaments, I'm afraid this was a combination of unusual conditions and a certain amount of self delusion. When first told of the trouble my friend had walked into the lounge-room without bothering to switch on the light, there being enough light from the adjoining room to enable him to see what he was doing.

He realised afterwards that he had never viewed the chassis under these conditions before, and failed to realise just how bright the filaments appeared inside the cabinet in a dark room. This, coupled with the fact that he was expecting something to be wrong, was all that was needed to start the train of thought.

While this was an extreme case, stretching the factor of coincidence beyond what one might reasonably expect, it does illustrate how easy it is to be misled. The only way to guard against such mistakes is to be very sure that what one thinks one sees is, in fact, really so. But of course it is easy to be wise after the event.

Reverting to my original theme—the comparison between the two reactions to a faulty set—I can only emphasise that it is far better to be a little over cautious than deliberately careless concerning any obvious defect in a set's performance.

COMPARISON

If you are wrong in the first instance there is little to lose. It may not even be necessary to call the serviceman to the set, a reasonably accurate description of the effect will usually enable him to say whether further investigation is justified.

But if you are wrong in the second instance it may well be that the fault (no matter how trivial as far as performance is concerned) is seriously overloading expensive components. When these fail they may overload others, creating a chain reaction which may ultimately prove extremely costly.

Though, come to think of it, why should I worry?

To round things off, I feel bound to quote from a letter I have just received from Mr B. H. L. of Raleigh, N.S.W. It is particularly interesting, I feel, because Mr B. H. L. is in no sense a professional serviceman. In fact, I am quite sure that he would be the first to agree that his experience is strictly limited. This is what he says:

"I was called on to fix a broken dial cord in one set, and this also suffered from bad acoustic feedback. The owner said that this had been evident since the set was new, resulting in many expensive service calls which did not cure it.

"Using the 'bash' technique, I quickly found it was around the tuning gang. Closer examination showed that the ceramic insulator on the oscillator section of the gang was broken, and that that section was very free to move by vibration.

SIMPLE APPROACH

"To cut a long story short I made a metal and bakelite strip and fixed it to the side of the gang, then soldered to the connecting tag on top.

"This seemed to fix the trouble, and the owner told me recently that it appears to be completely cured."

I can only say that the servicemen who preceded Mr. B.H.L. must have been a pretty poor lot. The fact that a comparative amateur was able to track down the trouble in a few minutes, using nothing more than a screwdriver and some plain ordinary "horse-sense" is a positive indication that the fault was not a particularly difficult one.

How, then, did the professionals miss it? Was it straight out technical incompetence, or was it simply lack of attention to the owners' original complaint?

We shall never know, of course, but I am inclined to the latter theory. Such inattention, coupled with possible intermittent activity on the part of the fault, could easily lead to its being overlooked: a fact I have been able to demonstrate in these columns many times in the past. My bet is that this was just another typical example.

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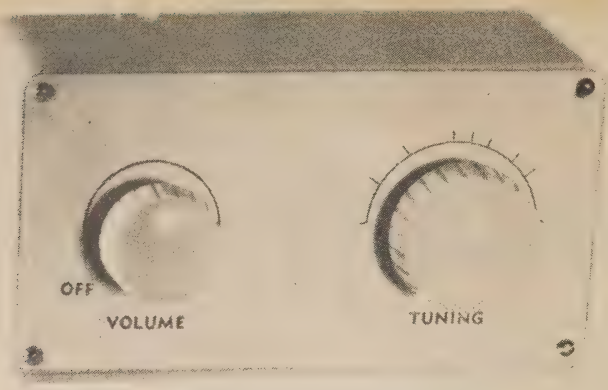


Here is the set with a simple scale to indicate stations. Cabinet is a matter of personal choice.

Extra Performance From One Transistor

Low-loss ferrites plus a modern RF type transistor go together to make the most efficient single stage receiver yet to appear in "Radio, Television and Hobbies". Interstate reception is possible with any reasonable aerial or, for locals, a "loopstick" may be substituted for the ferrite toroidal coil. Velvet smooth regeneration makes adjustment easy.

by Maurice Findlay

THIS is the second time we have described a small transistor receiver. Some of our readers will remember the single transistor regenerative receiver which appeared in the June, 1957, issue, followed by a similar receiver with an audio amplifier stage which appeared in the July, 1957, issue.

As we mentioned in the article, RF transistors were not in very good supply at that time and, unfortunately, only a few weeks after the article appeared, it was very difficult to buy a suitable transistor.

Since then the position has improved to the point where we do not expect you to have any difficulty in buying any one of at least four transistor types suitable for the set in more than one brand.

A BIG SET

We have already catered for those who wish to build a full-size portable with the "Transporta Six," which appeared in the August, 1958, issue. As time goes on, we will be able to describe still larger receivers to suit those with expensive tastes, as well as simplified sets designed with the idea of keeping costs down to bedrock.

Transistors hold the promise of making possible all the combinations and permutations of receiver types so far designed using valves, together with a few special ones which rely on the transistor's unique properties.

At "Radio, Television and Hobbies," we only wish that we could find the time to try and develop all the ideas on transistor receivers we have already written in the "little black book." The next few months should see at least some of them appearing in print.

LOW COST

Our present receiver uses only the one transistor in a regenerative arrangement.

It can be shown by analysis that the single transistor actually performs three functions. First of all it "detects" the incoming radio frequency carrier wave. By detection we refer to the process of extracting the modulation components (voice, music, etc.) which are impressed on the carrier wave at the transmitter.

This is necessary because headphones and loudspeakers will not respond directly to the radio frequency carrier wave.

It is possible, of course, to construct a receiver consisting of nothing more than a detector and a pair of headphones. However, such a receiver would be practical only in special circumstances, because it would have no ability to separate stations on different frequencies.

If a tuned circuit, consisting of a coil and capacitor, is added, the desired station can be selected and stations on all other wavelengths attenuated. A detector, a pair of headphones plus a tuned circuit go to make up the simple crystal set with which most readers are familiar.

LIMIT TO VOLUME

The serious disadvantage of the crystal set is that it depends entirely on the energy collected by the aerial to operate the diaphragms of the headphones. This is usually quite small and it is therefore not possible to obtain very much volume from them.

A valve or a transistor can amplify as well as detect and thus it is able to make the signals in the headphones louder. The power which operates the diaphragms of the headphones actually comes from the battery. Aerial power is only then required to perform a control function and the headphone volume can be much greater.

It is possible to amplify the incoming signal to a very high level by the use of a number of stages if required.

Amplification of the detected signal is, therefore, the second of the functions performed by the transistor. In this case we wish to make the set simple and only the one stage of amplification is employed, but, if we wished to have more volume in the headphones or operate a loudspeaker, it would be possible to add one, two or more further amplifier stages.

The third function of the transistor is to amplify the incoming radio frequency signal. This amplified radio frequency energy can be very usefully employed in improving the efficiency of the tuned circuit.

You will remember we mentioned a moment ago that a tuned circuit is used to select the desired signal. No tuned circuit is 100 pc efficient, and some of the energy is wasted in transition from the aerial to the detector.

REGENERATION

However, by feeding some of the amplified radio frequency back to the tuned circuit it is possible to make up the losses, when the tuned circuit will behave as though it has very, very low losses.

It is, in fact, possible to make up for the energy which is fed to the detector and dissipated in other parts of the circuit in such a way that the overall improvement in amplification is very great.

This condition depends on exactly the right amount of energy being fed back. If too little feedback is applied there will be little improvement in performance. If too much energy is fed back, the transistor or valve as the case may be, will generate a radio frequency signal on its own account. This will beat, or heterodyne, with the carrier wave from the radio station and produce a continuous whistling note in the headphones.

The idea is to adjust the feedback so that the circuit is just on the verge of oscillation. Since the setting is critical and depends on a number of factors it is necessary to have a variable control for regeneration.

In small sets this control can also serve as a volume control because reducing the feedback slightly reduces the efficiency of the circuit and hence the volume. When a number of stages of amplification are employed it is usually desirable to have a separate volume control.

SEPARATING STATIONS

Yet another function of the regeneration is to improve the selectivity of the receiver. In other words, its ability to separate the required station from other stations close in frequency. A carefully adjusted regenerative detector can be made to give excellent results in this regard, considering the overall simplicity of the arrangement.

It can be seen, therefore, that the regeneration control is very important in a simple receiver and that for good results and ease of handling it must operate very smoothly.

Let us now take a look at the circuit diagram. There are not so very many parts in the set but of these perhaps the most important is the transistor itself.

Practically any transistor will detect radio frequency signals with reasonable efficiency and amplify the resulting audio frequency components. Smooth and reliable regeneration demands that the transistor be able to amplify signals up to a frequency of at least 1.5 Mc.

Tests with our experimental receiver indicate that both the OC44 and the 2N252 are excellent as regenerative detectors and you can please yourself which one you choose. It is possible that the final choice will be influenced by plans for future building and if you see a larger circuit which you feel you may like to try later, use a transistor which is specified for the larger circuit.

DON'T CUT LEADS

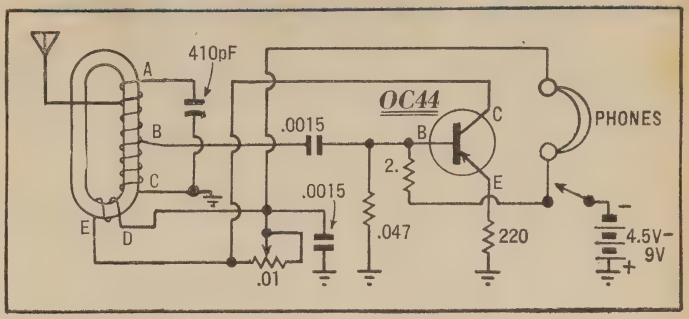
Worth remembering is our suggestion in an earlier article that the transistor leads be left full length and covered with spaghetti tubing. Heat from the soldering iron is not likely to damage the transistor and there is no need to worry about bending the end of the wire for soldering purposes.

It is always a good idea to grip the lead with a pair of long-nosed pliers between the transistor and the joint, the pliers acting as a heat sink but, with the full-length leads, you probably would not damage the transistor, even if the heat sink were omitted.

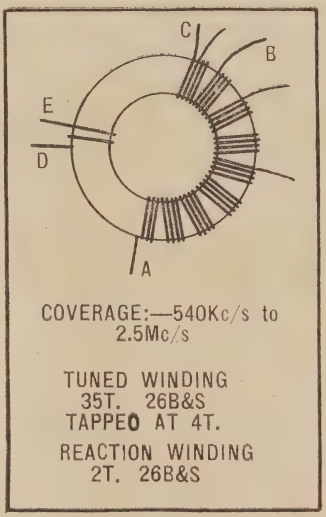
Slightly better performance will be achieved with the 2N252 if the forward bias resistor (2.2 megs on circuit) is reduced to 1.0 meg. Types 2N308 and 2N309 can both be used under the same conditions as the 2N252, but the overall performance will not be quite as good. Similarly, the OC45 may be used in place of the OC44 but, since it is designed for operation at lower frequencies, the performance will not be quite as good.

Perhaps the next most important component is the tuning coil. Any one of the three different arrangements we have suggested is worth trying or you can build all three and compare results for yourself.

TRANSISTOR RECEIVER CIRCUIT



The circuit is very simple. The performance depends on the qualities of the transistor and the tuned circuit. The ferrite ring is recommended but data on three types of coils is given.



This diagram shows you how to wind the coil on the ferrite ring.

Data for an ordinary air-wound coil similar to that suggested for the set described in the June, 1957, issue is given and will give good results. It is easy to wind and will suit those who are temporarily unable to obtain the ferrite ring.

However, for the really excellent results which are possible with this set the ferrite ring is strongly recommended.

The coil is wound on the ferrite ring in the form of a toroid and, despite the fact that it occupies a fraction of the volume of the air-wound coil, its efficiency is very much greater. In fact, the efficiency is even greater than that of the largest air wound coil you are likely to be able to wind.

EFFICIENT COILS

We remember some of the large coils which were constructed in the early days of crystal sets with the object of improving efficiency. It was not uncommon to make a coil 4in in diameter and 4 or 5in long. Even so, the efficiency of the coil would not be as good as that of the ferrite toroid.

The particular item we have used is the same as that suggested for the radio frequency filter described in the November issue. It is manufactured by Ducon General Ceramics and is identified by the part number F4021.

Because the losses of the ferrite toroidal coil are so low, the amount of energy which has to be fed bgack in order to make the circuit oscillate is small. This results in smooth control of regeneration, good selectivity and high amplification each in turn. We strongly recommend that you use this type of coil.

It has the further advantage over other coils that the magnetic field is virtually confined to the ferrite material itself and the coil can be mounted close to large metal objects, for example the tuning

PARTS LIST

- 1 piece of bakelite 5½in by 2 3/8in.
- 1 piece of bakelite 2 3/8in by 1½in.
- 1 transistor OC44, 2N252, OC45, 2N308 or 2N309.
- 1 single section tuning capacitor.
- 2 0,0015 uF mica or ceramic capacitors.
- 1 10,000 ohm carbon potentiometer with switch.
- 1 2.2 meg resistor.
- 1 0.047 meg resistor.
- 1 220 ohm resistor.
- 1 pair of high resistance headphones.
- 1 miniature crystal socket.

Hook-up wire, tinned copper wire, enamel wire, eyelets, nuts and bolts, Ferrite ring, ferrite rod or ¾in cardboard former according to type of coil required.

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P/N 266 7 holes x 9in .. 7
P/N 267 7 holes x 12in .. 9/7
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capacitor, without spoiling its efficiency.

The insulation of the coil for leakage currents is still important and we recommend that it be mounted against a piece of high quality insulating material such as high quality bakelite of polystyrene.

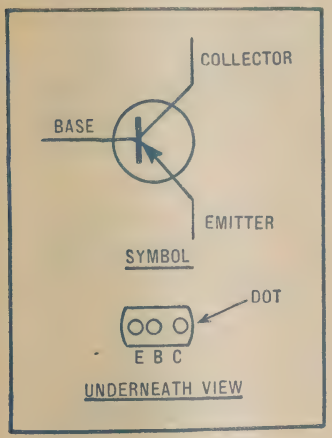
An exceedingly important point is that the mounting of the coil should not be such that it gives the effect of a shorted turn.

FERRITE AERIAL

Some readers may like to experiment with a ferrite rod aerial, often referred to as a "loopstick." The standard rod used for aerials is about 3/8in diameter and 8in long. Data on a suitable coil is given here. It would be permissible to wind a fixed coil directly on the rod but if the coil is wound on a cardboard or laminated bakelite former it is possible to vary the inductance over a useful range by sliding the coil along the rod.

Inductance is greatest with the coil at the centre of the rod and least with the coil at the end of the rod. Therefore, moving the coil toward the centre of the rod has a similar effect to adding turns and moving the coil toward the end of the rod the same effect as removing turns.

While the signal pickup of the ferrite rod is quite low compared with that of a reasonable external aerial and earth, it is still possible to obtain worthwhile

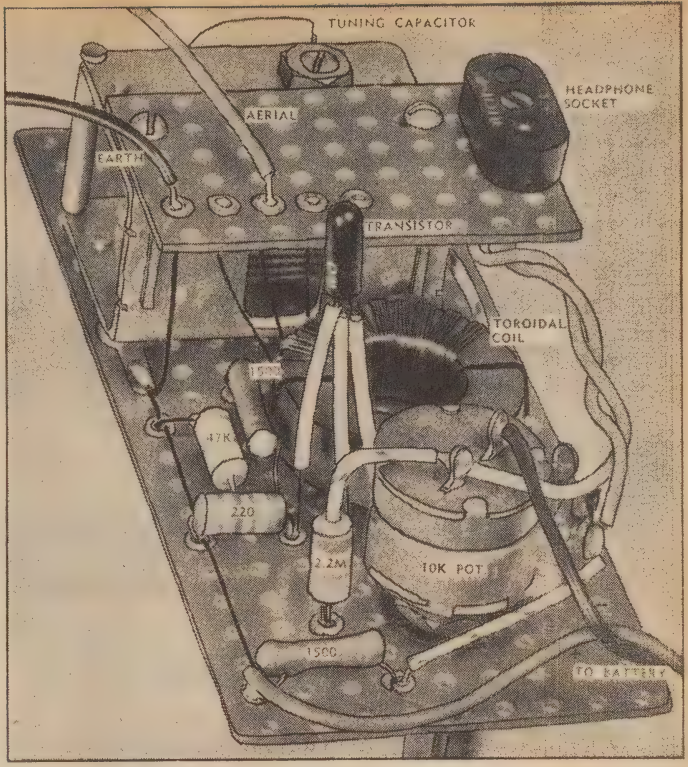


Connections to the transistor are identified above.

results from local stations. As a rough guide, we would say that it is possible to obtain useful headphone volume at distances up to 10 miles airline from powerful stations. Signals are strongest when the rod is horizontal and at right angles to the line between the set and the station.

Together with the variable capacitor, the tuning coil we have just been discussing forms a selective circuit the natural resonant frequency of which can be varied over the entire broadcast band by varying the setting of the capacitor.

Actually, if wired exactly according to the circuit the set will cover frequencies much higher than the top of the broadcast band because the total minimum



Most of the wires and connections in the set are visible in this photograph. It should be compared with the circuit diagram on page 49.

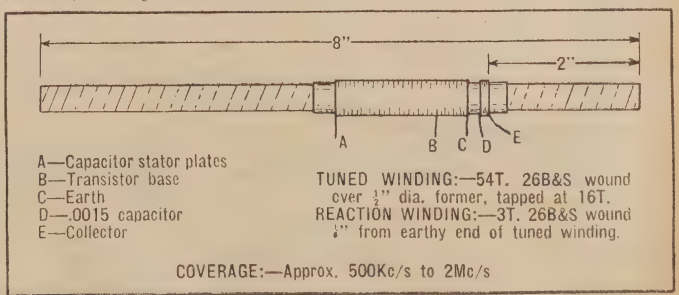
capacity of the circuit when the plates are fully out of mesh is very low. Coverage can be reduced and ease of tuning at the high frequency end of the band improved, if a 0-50 pF trimmer capacitor is connected across the main tuning capacitor and appropriately adjusted.

Should you wish to use a dial with the stations marked the trimmer will be needed to make the positions of the stations correspond with the markings.

With a small regenerative set such as this, in which the aerial is directly coupled to the tuned circuit, the exact positions of the stations will depend on the type of aerial you use and the adjustment of the regeneration control. However, for a given aerial it will be possible to station calibrate the dial with quite good accuracy.

First of all tune the set to a station at the high frequency end of the band and adjust the trimmer so that the position of the station corresponds with its dial marking. Then, tune to a station at the low frequency end of the band. If it appears at a higher frequency position than marked the inductance of the coil is too high. It can be reduced by removing turns in the case of the ferrite ring and the coil wound on the cardboard former or by sliding the coil towards the end of the rod in the case of ferrite rod.

For a start, remove one turn, tune the set to the high frequency end of the



Details of the ferrite rod aerial which is suitable for reception of local stations.

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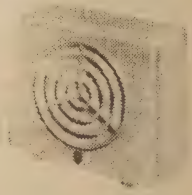

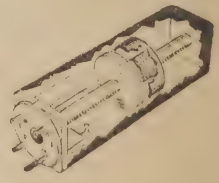

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band and adjust the trimmer as before. Again tune to the low frequency end of the band and note the new position of the station. It may be necessary to remove yet another turn.

Should the station initially appear at a position towards low frequency end of the band from the marked position, you will need to add one or more turns. For this reason it may be best to start with a coil having one or two more turns than specified. It is always easier to remove than to add turns.

The job of winding the air core coil is a little tedious because of the large number of turns involved and the toroidal coil on the ferrite ring is difficult to wind because a long length of wire has to be passed through the centre of the ring once for each turn.

WINDING COIL

In the latter case 4½ft of wire will allow some to spare. It is easiest to begin winding at the centre and wind in one direction until the wire runs out and then in the other until the required number of turns has been wound on.

Normally turns will be close-wound at the inside of the toroid and spacing will be required at the outside because of the greater diameter. Instead of attempting to space the turns evenly, we suggest that you wind in groups of four. Although in this case an unevenly spaced job will probably be just as efficient as a very neatly wound coil we usually like to make our sets as workmanlike as possible.

Wire gauge specified is 26 B and S, but the exact gauge is not really critical. We suggest that you do not use wire very much thinner because the efficiency of the coil will be lowered. You could use heavier wire when the efficiency may even be slightly higher but the disadvantage is that it is difficult to wind the coil neatly.

Both from the point of view of efficiency and for convenience, it is best to add the taps to the toroidal coil after winding. Scrape the enamel away from the particular wire, tin and solder the tapping wire in position.

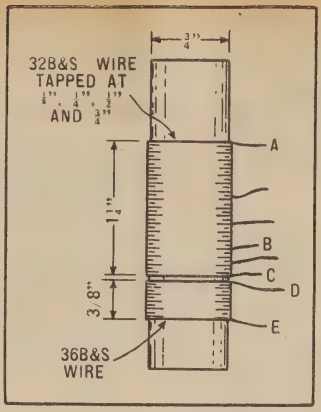
Efficiency of the air wound coil is relatively low, so that the extra length of wire introduced by twisting a loop for a tapping point will not be of any consequence. In the case of the aerial rod it is more difficult to solder a tap in position because all turns are close spaced and a loop twisted in the wire may be the best solution.

PRACTICAL VARIATIONS

Although only the one tap is normally required for the rod aerial, it may also be provided with a series of taps permitting the connection of external aerials of various types. We would not expect the overall efficiency of this arrangement to be as good as with the toroidal coil.

There is little difficulty in adding the feedback winding for any of the coils. Individual transistors of the same type do vary greatly in their characteristics and for this reason we suggest that you be prepared to vary slightly the number of turns on the feedback coil. For example, with a particularly high gain transistor one turn on the feedback winding of the toroidal coil may be sufficient.

The ferrite rod and air coil have both windings in the same direction. Note diagram for the ferrite toroid.



A coil wound to the above specifications will permit good reception of local stations.

We have suggested four taps on the coil and these will cover the majority of requirements. Best results will be obtained with a short aerial by connecting it to a tap near the top, while for a long aerial a tap near the bottom is desirable.

Those with an experimental outlook may care to try taps in positions other than those suggested.

Regeneration is controlled by a 10,000 ohm potentiometer. While an older type tuning capacitor, resistors or capacitors may be permissible, we suggest that the potentiometer be one component about which there be no compromise. A new carbon pot. of good quality is called for. A built-in switch keeps the overall number of controls down to two.

Resistor values are not critical in that ordinary ½-watt types with a tolerance of 20 per cent are okay but do not vary from the suggested values. The two fixed capacitors may have marked values between about 1,000 and 2,000 pF. The lowest voltage rating you can obtain will be in order.

HEADPHONE CONNECTIONS

Headphones are usually sold with metal tips terminating the leads. Special sockets for these tips have been available but appear to be scarce just now. Spring loaded terminals are efficient in making a firm connection and inexpensive but have the objection of taking a lot of space in what may otherwise be a compact receiver. Telephone type jacks and plugs are efficient but tend to be bulky and cost much more.

Perhaps the best solution is to use a

(Continued on Page 119)

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FURTHER NOTES ON R-C BRIDGE

The Resistance-Capacitance bridge, described in the September issue last, has proved extremely popular with our readers. Here are a few additional notes on the instrument, which may be of further assistance.

THE instrument met with an immediate response, partly because it happened to be presented at just the right time and partly because one of our advertisers made available a front panel carrying all the necessary markings and a complete value and tolerance scale to our specifications.

Knowing that this scale would be made available, and being short of space in the September issue, we did not print a separate copy of it. However, we have since had several requests for the scale from readers wanting to copy it photographically or otherwise, with a view to incorporating it in a panel layout of their own choosing.

The original scale is accordingly reproduced herewith, and further copies on glossy paper will be available for those who want them, through the normal 2/ Query Service.

NEW SCALE

The new scale differs somewhat from the one published for the earlier version of the bridge (December, 1954).

The latest bridge used a Naunton potentiometer, which is more elaborate—and more expensive—than the receiver-type control used earlier.

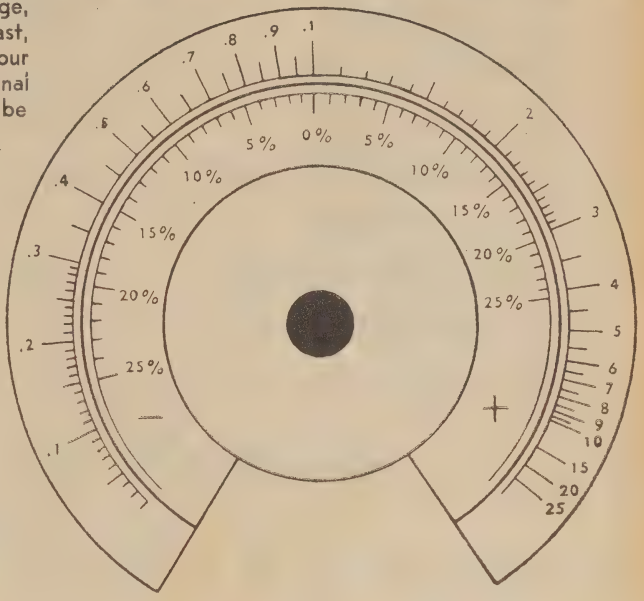
The new potentiometer was used with a supplementary resistor to give the same scale length as before, but its larger diameter resistance element allowed the calibration points to be plotted with more certainty. As a further step, the two halves of the scale were cross-checked, one against the other, to average out any residual errors.

When duplicating the bridge, it should be sufficient, for most purposes, to use a standard Naunton pot. of the recommended value and a 75-ohm series resistor. However, possible slight variations in the angle of rotation may occur due to the position of the contact strip at each end of the element. This can be countered, if desired, and the pot. calibrated individually to the scale by varying the value of the series resistor from the suggested 75 ohms.

It must be stressed that this calibrating procedure can only be used where the travel of the potentiometer arm for zero-ohms to zero-ohms is less than the angle provided for in the scale. This is true of the Naunton pot. but quite a few other odd potentiometers which we tried, including disposals types, describe a larger arc

These cannot be compensated electrically, though it may just be possible to short out one end of the element and add a new stop—if the effort is worthwhile!

If it is desired to use a cheaper potentiometer, the standard IRC wire-wound type works very well and fits the scale almost exactly without any series resistor. However, in one instance we were able to check, a marginal improvement in the final accuracy was achieved by wiring a 22-ohm resistor in series with one lead.



Here is the scale for our latest R/C Bridge, detailed in the September, 1958 issues. Copies of the scale on glossy paper can be obtained through our 2/- Postal Query Service.

Remember that the addition of a resistor in series with one end of the resistance element will shift the electrical centre of the network and necessitate relocating the pointer on the pot. shaft.

METHOD OF TESTING

The simplest method of checking all this is to obtain three resistors known to be accurate, one equal in value to one of the internal standards, one ten times up and the other ten times down. An accurate 1K, 10K and 100K are an obvious choice and could possibly be selected from stock by your normal parts supplier.

Simply set the pointer for balance on say, the 10K range, with the 10K resistor in the "unknown" terminals. Then substitute the other resistors in turn and note how closely they fall to the "0.1" and "10" graduations on the scale.

If they fall inside the graduations, add resistance to the pot. Reset the pointer and check again. If they fall beyond the appropriate graduations, the amount of resistance in series with the pot. element must be reduced.

We suggest calibrating to the "Tenth" and "Ten Times" points as being the most obvious and satisfactory. Points closer to unity will not show the spread of the scale quite so clearly, while those beyond 0.1 or 10 may suffer some loss of accuracy, because they approach very close to the limit of travel of the pot.

There is no special virtue in the value of 2500 ohms for the balance potentiometer except that, in the original instance, it was readily available and wound with wire which was neither so thin as to be delicate or so thick as to give jumpy readings.

If you are particularly interested in using the bridge for tolerance readings, the value of the potentiometer can be reduced with some advantage. With a lower value pot. the series resistors necessary to make it read plus and minus 25 p.c. are also lower, reducing the overall resistance of the balance circuit and rendering it less prone to interference from stray hum pick-up.

TYPICAL VALUES

Typical values, on this basis, are 1000 ohms for the potentiometer, 2200 ohms for the "tolerance" resistors and calibrating resistors of 30 ohms for a Naunton potentiometer and 10 ohms for an IRC.

Proportionately lower values of potentiometer and resistors could be used, provided the pitch of the resistance element does not become so coarse as to prejudice reading accuracy.

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(Continued on page 73)

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PART 32—SAWTOOTH OSCILLATORS (Cont.)

Having, in the last instalment, discussed the multivibrator and the "Synchroguide" method of automatic line frequency control, we pass this month to an examination of other commonly used automatic frequency control circuits.

AS indicated in the previous article, the use of automatic frequency control is normally restricted to the line oscillator circuit, mainly because it is far more prone than the frame oscillator to interference from random noise impulses.

In broad terms, line oscillator A.F.C. systems involve the use of a sensing or comparator circuit, which compares the incoming line synch. pulses with the output frequency of the line oscillator and produces a proportional D.C. potential when the latter deviates for any reason at all.

This DC potential is applied to correct the frequency of the oscillator in the appropriate direction, thus keeping the receiver line scan in synch. with the transmitter.

The correction voltage is always applied through a circuit having a relatively long time constant, so that the oscillator cannot suddenly be disturbed by individual stray interference pulses nor by the loss of occasional synch. pulses.

In a blocking oscillator or multivibrator, as already discussed, the blocking frequency (and therefore the sawtooth output frequency) is affected by the DC potential applied to the return resistors of the blocked grid (or grids).

Automatic frequency control may, therefore, be achieved by applying the corrective voltage to the grid return circuit in the appropriate polarity.

This is the principle behind the "synchroguide" circuit discussed in the last instalment. The corrective voltage, in this case, is generated in the cathode circuit of a valve, whose average cathode current depends on the phase relationship of pulses from the synch. separator and from the sawtooth output circuit.

DC CHANGES FREQUENCY

The oscillator grid resistor returns to this cathode circuit and the polarities are such that any divergence of the oscillator from the transmitted pulse frequency varies the cathode potential and therefore changes the blocking frequency of the line oscillator to correct the drift.

This general method of developing a control voltage in a valve cathode circuit is often referred to as the "pulse-width" system, a term which is readily justified by figure 176 in the last instalment of this series.

While the pulse-width system is commonly associated with a blocking oscillator to form the complete "synchroguide" circuit, the association of the two is not an essential one. There is no basic reason why a pulse-width control valve should not be associated with a multivibrator, or why a blocking oscillator should not derive its corrective control voltage from some other type of comparator circuit.

Figure 177 shows another typical and popular AFC arrangement in which what is often called a "synch. discriminator" control stage is associated with a multivibrator type line oscillator.

The actual synch. discriminator stage involves a twin-diode, which is commonly a 6AL5. Synch. input signals are fed to the cathode of one diode and the plate of the other, their complementary electrodes being connected together and sharing a common return circuit.

The synch. information fed to the discriminator stage must be in "push-pull," the signals to the respective diodes being of equal amplitude but of opposite phase. This involves the use of a phase-splitting or inverter stage ahead of the diode discriminator and more will be said of this a little later.

Since the two diodes are connected in opposite sense and fed with balanced out-of-phase synch: information the rectified current from each would normally be equal but of opposite polarity. Therefore zero voltage would be developed across R3, which is common to both.

HOR. OUTPUT

However, this basic function is modified by the fact that a "sample" of the horizontal output waveform is applied to the common plate and cathode circuit. Thus the conduction through each half of the diode depends both on the synch. input waveform and the instantaneous potential which happens to be present on its complementary electrode.

Figure 178 shows the possible relationships which can occur in the synch. discriminator stage. Note that in all diagrams the synch. pulses are shown as having opposite polarity, while the reference pulse from the line output circuit has the same polarity in each diode.

The first diagram shows the normal idealised condition, in which the synch. pulse occurs halfway along the flyback or retrace line. It will be apparent from the diagram that this will apply an equal pulse voltage to each diode element, so that the rectified resultant current through the loads R1, R2 and R3 will balance and cancel.

If the oscillator tends to lag the synch. pulses for any reason the pulses will occupy the position shown in the centre. Higher peak voltage will occur across the upper diode and its positive rectified current will predominate in the common load resistor R3.

PROPER CORRECTIONS

Since R3 is part of the multivibrator grid return any positive-going voltage applied to it will reduce the blocking period and therefore increase the sawtooth output frequency. This would be the correction needed if the oscillator was in fact tending to lag.

Conversely, if the oscillator tended to lead the synch. pulses by running at too high a frequency the lower diode would predominate, producing a negative-going shift across R3 and therefore lowering the blocking frequency.

The vital point about the circuit is that the potential at the grid is stored as a charge by the .047mfd. capacitor wired between grid and earth. Substantial long-term changes in frequency can be effected only at the rate at which this capacitor can be further charged or discharged through the 0.47meg. series resistor.

The time constant is much too long for the oscillator to show any immediate

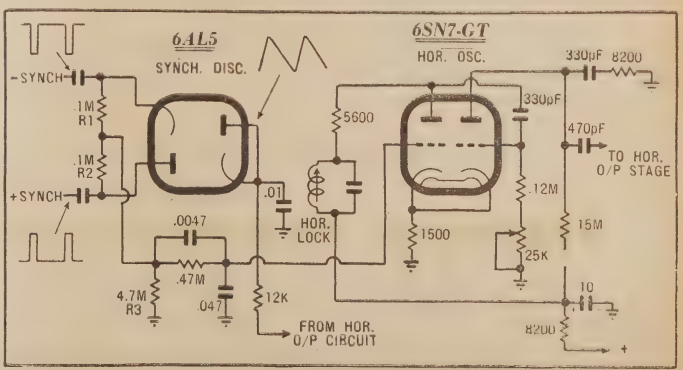

Figure 177: A typical circuit for a diode synch. discriminator controlling a multivibrator type line oscillator. Note that the discriminator requires out-of-phase synch. input signals but a "single-sided" comparison voltage from the horizontal output circuit. The DC voltage generated is applied directly to the multivribrator grid.

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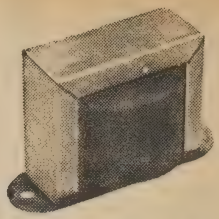

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or obvious reaction to individual spurious noise pulses or, conversely, to the loss of occasional synch. pulses proper. The .005mfd. capacitor shunting the 0.47meg. resistor allows a minor amount of short-term correction and serves much the same purpose as the anti-hunt components in the synchroguide circuit.

The remainder of the circuitry in figure 177 is fairly conventional. The 6SN7-GT is a cathode-coupled multivibrator, with the grid already discussed available for automatic frequency control purposes.

HORIZONTAL HOLD

Manual adjustment of the free-running frequency is provided by a variable resistor in the grid of the right-hand triode. This forms the normal "Horizontal Hold" control and is simply rotated until the picture locks. Thereafter the automatic circuit should be adequate to maintain locking automatically, though more careful setting of the manual control will bring the free-running frequency close to optimum and avoid violent tearing of the picture when the receiver is switched from channel to channel.

The plate of the right hand triode, being the one which remains at cut-off for the greater period, is connected to the external sawtooth capacitor, in this case marked 330pf. The 8.2K resistor in series with the capacitor adds a spike to the sawtooth, to produce an ultimate trapezoidal pattern, which is fed to the grid of the horizontal output stage.

The tuned coil in the first plate circuit is a sine-wave stabilising coil, as mentioned in an earlier article. It helps to stabilise the natural frequency of the oscillator and make the following grid approach conduction much more sharply than it otherwise would.

It has a bearing also on the free-running frequency of the oscillator and is normally adjusted in conjunction with the "Horizontal Hold" potentiometer to obtain best stability and ease of control. As with the sine wave coil in the synchro guide chanel, adjustment is normally by means of a variable slug, accessible above or behind the chassis.

Since the foregoing circuitry requires equal and out-of-phase synchronising signals, some steps must be taken to provide them. As will be apparent from earlier discussion, ordinary synch. separation stages merely provide "single-ended" output, either positive or negative going in sense, as required by the following circuitry.

Where "push-pull" synch. signals are required, it is necessary to include a phase splitting or phase inversion stage between the normal synch. separator and the diode discriminator.

In general, the circuitry used for this purpose resembles audio practice and the well known phase splitter, phase inverter or cathode-coupled inverter are all open to adaptation. The audio terminology is seldom preserved, however, and irrespective of the circuit details, the function of the circuit may simply be described in a TV receiver as "Synch. Inverter" or "Synch. Splitter."

Another point is that circuit values and practices do not necessarily duplicate those found in audio amplifiers. Whereas the phase inverting stage in an audio system is normally separate and distinct, the task of synch. inversion in a television receiver may be performed, for reasons of economy, by any odd section which happens to be "left over" in a multiple valve.

HIGH FREQ. RESPONSE

In arranging the circuit and wiring it is essential also to preserve good high frequency response, in order that the sharpness and phase relationships of the synch. pulses shall not be prejudiced. Since the synch. pulses are of angular shape and with a repetition rate of over 15,000 cps. a nominal frequency response to 200 or 300Kc. must be envisaged.

This being so, it is usual to find load resistor values somewhat lower than is common in audio practice.

A still further point is that low distortion is not significant in the same sense as for an audio amplifier. The valve is required to deliver sharp, balanced, out-of-phase pulses but with no information in between. It can therefore operate, if need be, from the cut-off region and be driven by positive-going signals.

If the grid is driven actually positive, grid and plate current both flow through the cathode resistor but, again, no complication need arise if the plate and cathode load values are manipulated to maintain voltage balance.

Conversely, the valve may operate at relatively high standing current and be driven beyond cut-off by large negative-going pulses. Provided good frequency response is present in the circuit, the output pulses will be subject to additional shaping and limiting.

Figure 179 shows an inverter stage extracted from a commercial TV circuit. Voltage figures indicate that the valve operates with an average current of just over 3 milliamps, with 11 volts at the cathode pin and 5 at the grid pin.

Very large negative-going pulses are applied to the grid, causing plate and cathode current to fall abruptly for the duration of each pulse. Negative-going pulses therefore appear at the cathode and positive-going pulses at the plate.

The plate load consists of two resistors in series. The smaller one, adjacent to the supply lines, has the same value as the cathode resistor and the pulse voltage developed across it is therefore the same as at the cathode pin but of opposite phase. The two are fed to the synch. discriminator.

TO VERT. OSC.

The much larger positive pulse, developed across the total plate circuit, is fed to the integrating network and thence to the vertical oscillator. In other words, in this particular receiver, the synch. inverter stage serves a twofold purpose: (a) It provides push-pull synch. pulses for a horizontal discriminative diode and (b) it inverts the negative output from the synch. separator to make it suitable for feeding to the vertical oscillator.

So much then for automatic frequency control, as applied to the blocking oscillator and the multivibrator. It is now necessary to examine an entirely different system of line scan generation, in which the sawtooth voltage is produced by a discharge valve triggered by a conventional sine-wave oscillator, operating at line frequency.

While this type of circuit has yet to be examined, it is a fairly well-known fact that a sine-wave oscillator cannot very well be controlled in terms of frequency by merely varying a potential applied to

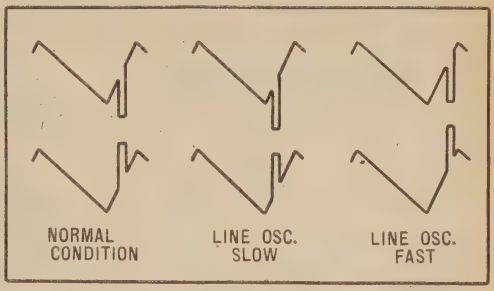

Figure 178: Three conditions which are likely to exist in the circuit shown opposite. At the left is the normal idealised condition; the centre diagram shows the synch. pulses leading and the oscillator slow while the diagram on the right reverses the situation.

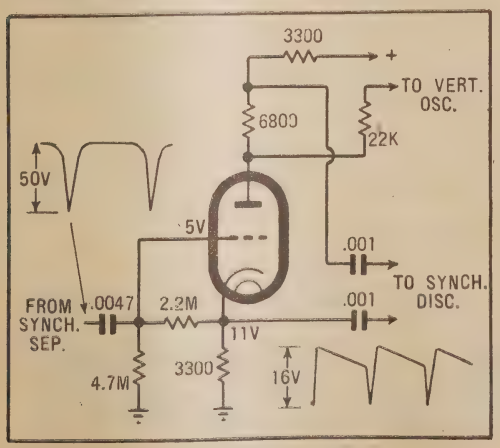

Figure 179: The synch. discriminator system shown in figure 177 requires balanced out-of-phase synch. input signals. To meet this requirement, some form of synch. inverter stage is necessary. The one shown here, from a commercial TV receiver, is typical.

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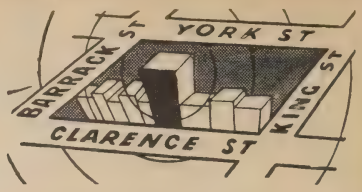

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one of its electrodes. To be sure, it may show some small shift in frequency with applied voltage but there is no definite control characteristic of the type exhibited by either the blocking oscillator or the multivibrator.

The frequency of an ordinary sine-wave oscillator (Hartley, Colpitts, etc.) is determined predominantly by the constants in the tuned grid or plate circuit and any substantial shift in frequency must be brought about modifying these constants, even if in some artificial way.

In practice, the method normally employed to achieve this result is the use of the so-called reactance tube circuit or reactance VALVE circuit, to use the more usual local terminology.

PENTODE, HEXODE

The reactance valve is usually a high-transconductance pentode, or other multi-grid type, connected in parallel with the tuned circuit. Energy is fed back from plate to grid through a network which changes the phase of the feedback voltage at the relevant frequency by about 90 degrees. This out-of-phase feedback component causes the plate voltage and plate current to exhibit a phase difference, the current lagging or leading the voltage by about 90 degrees, according to the arrangement of the feedback network.

This artificial voltage and current component, coupled across the tuned circuit, makes it behave as if, in fact, inductance or capacitance had been added, thereby changing the resonant frequency and the output frequency of the associated oscillator circuit.

The order of this reactive effect is dependant on the gain of the reactance valve, and therefore on its tranconductance and plate current. If these last are varied by means of grid potential the frequency of the oscillator circuit will likewise change.

A DC shift will produce a long-term change or, alternatively, the grid potential may be varied in cyclic fashion to produce a frequency modulation effect.

The basic idea is to adjust the oscillator for optimum frequency with the reactance control valve in circuit and with an intermediate effective value of transconductance. By then varying the grid bias about this resting value, the frequency of the oscillator can be shifted either way, as required, or varied in cyclic fashion.

AUTOMATIC CONTROL

For purposes of automatic frequency control, the controlling bias can be generated by some form of frequency discriminator circuit, normally one using a twin diode.

Figure 180 shows a basic reactance-tube controlled oscillator circuit, which will serve to illustrate the general principles more clearly.

The valve V2 is an ordinary cathode-tapped oscillator, whose frequency is determined predominantly by the tuned circuit components C and L. However, connected right across the two is the plate circuit of the reactance control tube V1. This latter is a multi-element type, in which two grids are available for control purposes.

The oscillator voltage appearing across C and L is coupled by C1 to the plate of the control tube. If the circuitry were to end here, this would merely cause a small in-phase current to flow through the control tube and the only effect would be that the oscillator tuning components C and L would be damped by the dynamic plate resistance of V1.

In point of fact, however, some of the voltage present at the plate by reason of C1 is fed to the number 1 grid of the control tube through capacitor C2. In practice, this last is made sufficiently small in capacitance for its reactance to be high compared with the value of R.

As a result of this relationship, a chain of phase rotation effects becomes evident.

Normal practice is to adjust the oscillator V2 to the desired centre frequency by means of C and/or L, and with the plate current, transconductance and gain of V1 at some intermediate value.

By now making the bias on the controlling grid less negative, the gain of V1 will increase, making it appear as a larger capacitor in parallel with C and L and therefore reducing the resonant frequency. Conversely, additional bias will increase the frequency.

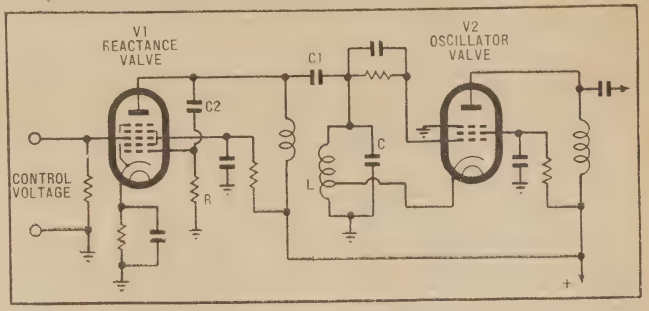

Figure 180: A typical circuit showing how the frequency of a normal oscillator V2, can be varied by applying audio or DC voltage to the grid of a reactance or quadrature valve V1

Firstly, because the network C2, R is capacitive, current through it leads the voltage by approximately 90 degrees. However, the voltage across R1 alone, being a pure resistor, must be in phase with the leading current. Therefore, the voltage to the number 1 grid of V1 must lead the plate voltage by approximately 90 degrees.

The valve plate current will tend to vary in sympathy with the grid voltage, which means that two separate influences will be at work on the plate current:

(1) It will tend to vary in phase with the plate voltage because of the natural dynamic plate resistance of the valve and

(2) It will have a component displaced by approximately 90 degrees by reason of the leading voltage supplied to the grid through C2 and R.

PLATE CURRENT

With a valve having a high dynamic plate resistance, the in-phase component is likely to be very small, which means that the valve merely appears to the tuned circuit as a device in which the current leads the applied voltage by approximately 90 degrees.

It behaves, therefore, as additional capacitance in parallel with C.

The value of this apparent capacitor, will obviously depend on the amount of plate current change effected by the "quadrature" or phase-displaced signal on the grid. It is therefore a function of the gain of V1 and can be related to its transconductance, its standing plate current and the voltages applied to various electrodes — in particular to the input control grid.

If, on the other hand, an audio or other cyclic waveform is applied to the controlling grid of V1, its shunt capacitive effect will appear to vary at an audio rate, so that the output from oscillator V2 will be frequency modulated.

POSSIBLE ARRANGEMENTS

The quadrature network (C2, R) shown in figure 180 is only one of several possible arrangements. Reversing their position changes the phase relationships and makes the valve appear as additional inductance. Alternatively, C2 may be replaced in circuit by a selected value of inductor, making the valve V1 appear as either an inductor or capacitor, according to the position relative to R.

Again, V1 may be replaced by an ordinary pentode and the quadrature feedback voltage applied to the cathode instead of to a control grid. This reverses all the foregoing relationships, because the reaction of plate current to cathode potential is the reverse of its relationship to a grid voltage. Thus, while a positive-going signal on a grid increases plate current, a positive-going signal on the cathode decreases plate current.

In the next instalment of this series, we shall examine a complete typical line sawtooth generator, operating around a reactance controlled sine wave oscillator

(To be continued.)

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Here's your answer, Tom!

This month's mailbag brings forth a query which is outstanding in that it is a paragon of ambiguity. From the tone of the letter it had apparently aroused considerable controversy among a number of enthusiasts who in their zeal to find an answer to a non-existent problem, overlooked a fundamental law and its correct application.

In the following circuit, what is the potential difference developed between the points A and B and how could this be measured to read the calculated potential difference? This question is the subject of much controversy and answers have ranged above and below 4 volts, common answers being 2.6 volts, 8 volts, 1.8 volts, 4 volts, etc.

The question as set out would appear to be a rather ambiguous one. As shown, it portrays a condition where .2A is supposed to be flowing, even though the circuit is open between points A and B.

If the circuit is, in fact, open at this point the potential difference between A and B would be 4 volts. This would be so regardless of the value of R, since there is no current flowing through R and no voltage drop across it.

However, in order to read this voltage it would be necessary to employ a voltmeter having infinite resistance (in theory) or (in practice) one whose resistance was very high relative to R.

If it is assumed that A and B are connected together without any resistance between them (as would be required in order to produce the suggested current flow of .2A) then the voltage between these points would be zero.

If any resistance is assumed to be between points A and B, then the figure of .2A no longer holds and, either the new value of current or the additional resistance would need to be known before the problem could be solved.

★ ★ ★

Recently I completed your Playmaster Baby Tuner which functions well in the wide range position but whistles on all stations in the selective position. I have checked and rechecked the wiring, which appears to be correct, as I very carefully followed the circuit. Could you suggest anything that could be wrong?

This was a question popped to one of our staff by a "Tom" who apparently was at wits end in trying to find a circuit fault in a tuner he had just constructed.

The symptoms automatically suggested instability in the IF channel which could have been the result of one or more faults. However, some probing by the staff member revealed that Tom was forced to lower the IF socket and in order to ensure clearance between the case and the bottom of socket (to quote Tom) he "cut off the little tube-like rivet thing which holds the socket together in the middle."

In our experience the above is not uncommon and the beginner frequently tends to overlook the importance of the centre spigot on a miniature valve socket, despite all we have to say about them in our constructional articles.

The centre spigot on a miniature valve socket is, in fact, a shield. As shields are always returned to earth or a point which is at or near earth potential (such as the cathode), so must this spigot be returned to earth.

The purpose of this spigot or shield is to minimise feedback of energy between critical element contacts on the socket, due to the capacitance between them.

In the case of RF or IF amplifiers, very little capacitance is required to produce serious regeneration. In Tom's case the gain in the wide band position was insufficient for the feedback to produce any instability but, in the selective position, the gain was such that feedback produced actual oscillation.

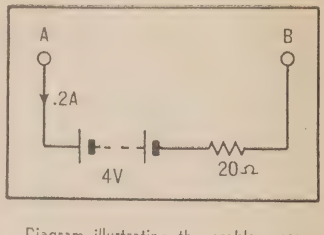

Diagram illustrating the problem contained in the first paragraph.

★ ★ ★

My son recently constructed a crystal set consisting of a germanium diode in parallel with a headphone set to which he connected an aerial and received 2FC quite strongly. Lengthening the aerial did not change the station or interfere with the reception. My knowledge of radio is limited and I am unable to give my son an explanation of why so simple a set works. Would you help?

Simple as the circuit may appear, the essential components for the demodulation and reproduction of an RF signal are contained in it.

The diode detector demodulates the signal picked up by the aerial while the headset reproduces the resultant audio

The fact that a tuned circuit is missing only prevents you from selecting a particular one of a number of stations. In fact, you should have been receiving them all in a jumble, due to the apparent absence of a tuned circuit.

The ability of the circuit to discriminate and select a single station indicates that some kind of a tuned circuit does, in fact, exist. This is most likely made up of stray capacitance inductance of the aerial and headphone wiring, which, combined, happen to be resonant at or near the frequency on which 2FC transmits. It might also be that 2FC is particularly strong in your area.

★ ★ ★

Fitting an earth wire to my set reduces the volume, while fitting the same wire to the aerial terminal, increases the volume. I have always been under the impression that the opposite is true. Where have I gone astray?

It is difficult to give an outright answer to a query of this type, Tom, unless it is possible to examine the equipment more thoroughly. However, the following may throw some light on your problem:

If the set is not fitted with an aerial and earth wire, the power mains act as an aerial and often contribute most of the signal. Although one side of the mains is earthed at various points, the distance involved allows the line to become an efficient collector of RF energy or, an aerial.

Since the chassis is not directly earthed, and is capacitively coupled to the mains, signal currents enter the chassis and the primary of the aerial coil, ultimately reaching the input grid.

Placing an earth wire on the chassis would naturally reduce the volume as it would divert most of the incoming signal. Adding the earth wire to the aerial terminal, on the other hand, would cause additional signal current to flow from the mains to earth via the aerial coil primary, thereby increasing volume.

★ ★ ★

What is the gain of a valve if it is not the amplification?

In broad terms, the "gain" or "stage gain" or "amplification" of a valve all mean the same and indicate by how many times the signal voltage at the plate is greater than the original signal applied to the grid. They all refer to the valve, as used in a complete circuit and therefore include any in-

fluence the circuit constants may have on stage gain.

What you probably have in mind is the "amplification factor," as quoted in valve data. This is defined as "the ratio of the change in plate voltage to a change in control electrode voltage in the opposite direction, under the condition that the plate current remains unchanged."

Amplification factor is a basic property of a valve, not related to any particular circuit and determined by the valve's internal construction. It is one of the factors which influence the performance of the valve in an actual circuit.

As a general rule, the stage gain or amplification of a valve in a complete practical circuit is lower than the amplification factor, as such.

★ ★ ★

What is the plate resistance of a valve as opposed to the plate load?

The plate resistance of a valve is the internal resistance of the valve when it is considered as a generator of power. This plate resistance is derived by dividing a certain small change of plate voltage by the resultant change in plate current. (See "Let's Buy An Argument" for September, 1958.)

Like any other generator of energy the valve must work into a proper load. Theoretically maximum power will be delivered into the load when it is equal to the plate resistance. However, it is not always practical to satisfy this requirement as, for example in a pentode valve whose plate resistance is very high.

Other considerations must also be taken in the choice of load. In a power amplifier stage it is desirable to select the highest load consistent with a low order of distortion. In a voltage amplifier it is possible to have a much higher value of load, since we are primarily interested with the voltage developed across the load.

Be that as it may, however, the plate resistance is an internal property of a valve. The plate load is the circuit or device into which or across which it delivers its output voltage, current or power.

★ ★ ★

How can the mutual conductance or any other data be used to find the internal resistance of a valve?

The relationship between the mutual conductance, the internal plate resistance or anode slope resistance as it is known, and the amplification factor is rather intimate. If any two are known the third may be derived from the relationship that the amplification factor equals the mutual conductance multiplied by the anode slope resistance

★ ★ ★

Why do vacuum tubes have a vacuum inside them?

We can't blame you for wondering, Tom. In fact, once we had to wonder too. Some emission from the cathode would take place in the open air, but there are two good reasons why the tube elements are placed inside a vacuum.

Firstly if the filament were heated to a red heat in the open air, it would quickly oxidise and burn itself up. Secondly if the space between the filament and the plate were not vacant, the tiny electrons would have a difficult time penetrating the bulkier atoms of air and gas. In fact, they just wouldn't reach the plate.

What is the purpose of RF chokes and why the variety of sizes, shapes and values?

An RF choke must offer high impedance to the passage of high frequency current through it. It offers this impedance primarily by reason of its inductance, produced by many turns of wire.

For relatively low signal frequencies, a large number of turns is necessary, in order to obtain high inductance, high inductive reactance and therefore high impedance.

For higher signal frequencies, a choke with fewer turns will suffice.

Another vital point is that there is always a certain amount of capacitance between turns in a choke so that signal currents which are blocked by the choke's inductance may successfully penetrate the choke by way of its self-capacitance —thus defeating the whole object of the device.

The more turns a choke has, the higher its self-capacitance is likely to be, unless very special section-winding techniques are used.

A still further effect is that the inductance and self-capacitance of chokes can resonate to create a particularly high impedance over a limited range of frequencies. We can therefore see, Tom, the reason behind a number of types of RF choke as under:

(1) Types with many turns and naturally high self-capacitance suitable for use at lower frequencies as, for example, the broadcast band.

(2) Types with fewer turns but low capacitance, suitable for higher frequencies, or short-wave.

(3) Types with several sections of different dimensions. They work over a wide range of frequencies (all-wave chokes) but are necessarily expensive.

(4) Special chokes designed to be resonant over a particular frequency band and used only in special applications.

And, of course, complicating all this is the fact that chokes may have to pass differing amounts of direct current. One may therefore find versions of all the above, with fine wire where little current is involved, to quite heavy wire where the application calls for high current-carrying ability.

★ ★ ★

I have seen the term "electrode current" used in technical articles, and wish to know what it means.

Electrode current, Tom, is the current passing to or from an electrode through the vacuum within the valve. Thus the terms plate current, screen current, cathode current and grid current are used to designate currents passing via these specific electrodes.

★ ★ ★

I have also seen the term "electrode voltage" used. Am I right in assuming that it is the voltage present at the valve elements?

The term valve elements is synonimous with valve electrodes, hence your supposition is quite correct. Electrode voltage is the voltage between an electrode and some specified point. The terms plate voltage, screen voltage and grid voltage are thus normally used to designate the voltage between these specific electrodes and the said reference point.

In valve application data, the reference point is quite often the cathode, or the

(Continued on page 123)

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Outwardly there are no obvious changes in the instrument, although it will probably be necessary to establish new points on the "CAL. ADJ." control, as explained in the text. This is also a good time to check and adjust the range multiplying resistors to compensate for drift.

Improvements To The Simple VTVM

One of the most useful pieces of test gear for the experimenter is undoubtedly the VTVM, and one of the most popular VTVM's we have described was a simple instrument designed way back in 1949. Here are a number of suggestions on how to increase the usefulness of this instrument, while still retaining its essential simplicity.

by Philip Watson

RIGHT from the outset we would like to emphasise that this is, quite definitely, not a constructional article on how to build a VTVM. If you have ideas about building such an instrument we suggest you wait a little longer, since we hope to incorporate the points arising out of this project into a new design in the immediate future.

However, if you built the VTVM described in the September and October, 1949, issues, then this article is for you. It describes some comparatively simple alterations and additions to the original instrument which will add considerably to its operating convenience.

CIRCUIT SUMMARY

To refresh our memory on this instrument, a brief discussion may be helpful. Basically, the circuit is that of the Wheatstone bridge, two of the arms being provided by the two sections of a twin triode valve (6SN7) and the other two being 50K resistors in the cathode circuits of the triodes. The meter connects between the two cathodes, replacing the galvanometer in the conventional bridge.

While ever the grid/cathode potential of both triodes remains equal, the bridge assumes a balanced condition, and there is no potential difference across the meter. However, as soon as a voltage is applied to one or other of the grids, the bridge is unbalanced and a voltage is applied to the meter.

Refinements include means to balance the bridge initially (Zero set) a calibration control (Cal. Adj.), means of reversing the polarity of the instrument to accommodate voltages both positive and negative referred to chasis, a rectifier for AC ranges, and a probe for RF measurements.

One of the main limitations of any simple bridge tyr VTVM is the tendency to a certain amount of zero shift under various operating conditions. Unless a fair amount of care is exercised, and the significance of the problem fully understood, this can lead to quite substantial errors in the final reading.

TWO FORMS

This trouble usually manifests itself in two ways. One may be a general drift from the zero position—rapid at first and slower as the instrument warms up—but which eventually stabilises after some 15 to 30 minutes running. While inconvenient, this defect can at least be overcome by allowing adequate warm-up time prior to making precise measurements.

The other effect is much more troublesome. It takes the form of an apparent shift in zero from range to range, being worst on the lowest range and virtually non-existant on the higher ranges. It does not decrease noticeably with warm up.

We use the term, "apparent shift," because it is not a true zero shift. It is brought about by the varying amount of resistance in the grid circuit (highest on the lowest range) and will thus be further effected by the resistance of the circuit across which the meter is finally connected.

Shorting the test prods will enable a more accurate zero setting to be achieved, and this will hold for external resistance values up to about 1 megohm. However, where the resistance is several megohms, the real zero will occur in some intermediate position which cannot be readily forecast. It thus becomes necessary to connect the meter to the circuit under test, while the latter is not energised, set the zero, then energise the equipment in order to read the voltage.

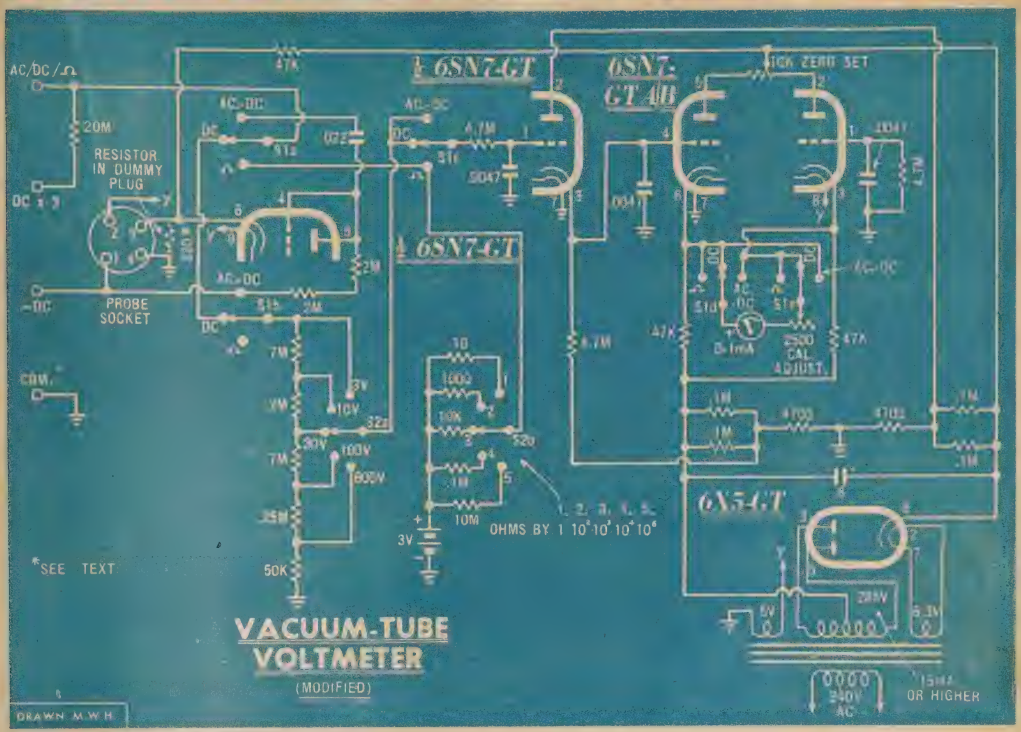
Not only is such a procedure irksome and time consuming, but it presents many possibilities for error if the operator is not fully aware of what he is doing. This is particularly so when ranges have to be changed back and forth and the entire setting up procedure carried out each time.

BASIC CAUSE

The basic cause of all these troubles is grid current in the valves concerned. This, in turn, may be due to a number of causes, varying from the characteristics of individual valves to the conditions under which they are operated.

In general, it may be said that all valves suffer from this defect to some degree, and that it is mainly due to the minute amounts of residual gas left in the envelope after evacuation. Unfortunately, no matter how well this job is carried out, it is virtually impossible to produce a perfect vacuum, so that we

CIRCUIT SHOWS IMPROVEMENTS TO THE ORIGINAL



The circuit shows all the changes necessary to bring your old meter up to date. Main changes are the fitting of the cathode follower stage, the reversing switch in the meter circuit, and the small value of bias applied to the diode cathode to minimise contact potential effects. All the original facilities are retained.

must always assume that this effect will become evident if we make the operating conditions stringent enough.

Another cause of the same effect is actual grid emission. This is due to the grid being heated by its proximity to the hot cathode and may be aggravated by small particles of cathode material which become lodged on the grid during manufacture. Thus the grid gives off electrons in the same manner as the cathode.

POSITIVE VOLTAGE

Both effects have the same result. They cause a small amount of current to flow in the external grid resistor in such a direction as to create a small positive voltage at the grid. As far as the VTVM is concerned, the effect is exactly as if this amount of voltage had been applied to the grid from an external source, and the meter reads up the scale by this amount.

This would not matter, of course, if the value of resistance in each grid circuit always remained the same. Then the voltages appearing at each grid would cancel each other. Unfortunately, as we have seen, this requirement cannot be met. Changes in resistance from range to range and, worse still, as caused by the resistance of the circuit under test cannot be avoided. When they occur the balance of the system is inevitably upset.

In case all this should sound like a wholesale condemnation of the valve manufacturers and their products, we should hasten to point out that these effects normally become evident only when we try to use the valves under conditions not intended by the makers.

In particular, the use of very high values of grid resistance (between 5 and 10 megohms) will make these effects very evident, but they are also almost directly proportional to the amount of plate current involved.

There are various approaches to the problem of minimising these effects. One is to choose a type of valve which seems least prone to this trouble and then, if necessary, to select individual valves from stock on trial-and-error basis to find those which come within the required tolerances.

While a good design will usually specify the best valve type for the job, the idea of selecting the best valve from stock is normally out of the question as far as the home builder is concerned. While the commercial manufacturer may have ample stocks from which to draw—and an alternative use for those which do not measure up to requirements—the home-builder must take what comes over the counter or out of his own small stock. It is seldom that he would have more than two or three from which to choose.

Operating the valve at a reduced heater voltage is sometimes helpful where grid emission is troublesome, since less heat is then available to excite the grid. Since the cathode currents involved are normally small, emission may still be adequate when the normal 6.3 volt heater is operated on as little as four volts. However, this is about the limit, and five volts is a better all-round figure. (Remember that power varies as the square of the voltage change.)

Reducing the plate current (as by using larger values of cathode resistors) is very beneficial, but has a marked effect on sensitivity. While it would be possible to use a more sensitive meter movement (a practice which appears to be followed by some commercial manufacturers) much of the attraction of the VTVM is its ability to provide a sensitive instrument around a relatively cheap and rugged meter. Once we are committed for a substantially dearer meter a lot of the benefit of the circuit is lost.

RESULTS IN PRACTICE

We tried most of these measures on our own instrument, with varying results. Reducing the heater voltage to five did not help appreciably in our case but, since it had no obvious adverse effects, we left it in the circuit as a precautionary measure.

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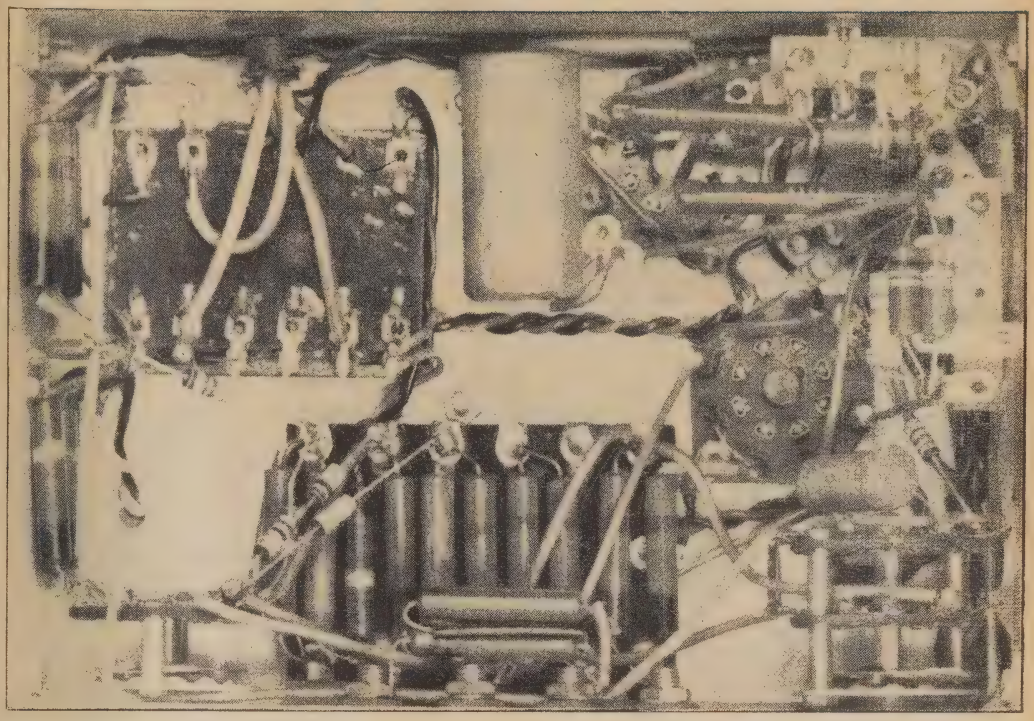
UNDERCHASSIS WIRING OF THE MODIFIED VTVM



An underchassis view of the modified unit. Note the terminal strips on rear and to side to accommodate the additional voltage divider resistors in the power supply, and the extra wafer on the function switch. These, plus another 6SN7, are the main additional components required.

We did not pursue the selection of valves to any extent, for the reasons already mentioned, but it does appear that the modern 6SN7GTA or GTB developed for TV circuitry is noticeably better than some of the older 6SN7GT's. If you are lucky, it may not be necessary to do more than purchase one of these, but it will not be wasted even if more extensive changes are necessary.

LIMITED IMPROVEMENT

Reducing the plate current proved helpful, but we were running out of sensitivity long before adequate stability had been reached. Fairly obviously, the existing values represented about the best possible compromise.

Since this exhausted most of the simpler possibilities we had next to consider what larger changes to the circuit could be justified, keeping in mind our original idea that this was still a simple instrument.

For inspiration we turned to our Senior VTVM of December, 1955, and January, 1956. In this instrument extreme care was taken to "design out" all the undesirable effects normally encountered in such instruments. In this respect the design was completely successful, and has proved to be one of the most popular "Senior" instruments we have ever described.

However, all this was achieved only at the expense of considerable circuit complexity. While completely justified for an instrument of this kind, it is rather out of keeping with the idea of the simple instrument we had been considering. Quite apart from the expense of the extra components, it would be physically difficult to accommodate everything within the smaller case.

In short, we had no intention of simply re-building the old instrument into the Senior VTVM. Rather we wanted something which could be achieved by means of a few simple changes and inexpensive additions to the original design, yet would incorporate most of the major advantages of the larger circuit.

The Senior VTVM circuit overcame the problem of grid curent in an ingenious manner. Instead of feeding the voltage to be measured directly into one of the bridge valves, it was fed to another triode acting as a cathode follower into the bridge valve.

ADVANTAGES

This arrangement has several advantages. The cathode follower may be operated with very low plate current so that grid current effects are virtually eliminated, in spite of the high value of grid resistance. At the same time the bridge valve, although still operating with a high grid resistance, now has a constant grid resistance regardless of the range selected. In practice it is particularly effective.

In order to preserve the highest possible order of balance, the Senior VTVM circuit provided a cathode follower in each grid circuit, once again using a twin triode. This was simple enough to incorporate in a new instrument, but was not so easy to add to an existing one.

A SINGLE STAGE

However, it seemed to us that it might be possible to get away with one cathode follower only and still retain most of the advantages of the scheme. If so, it would be possible to use the octal socket now used for the 6H6 to accommodate another 6SN7, one half serving as the cathode follower and the other half wired as a diode to replace the 6H6.

The idea was so simple that it took only a few minutes to temporarily rewire the appropriate portions of the circuit and try it. The results were extremely encouraging. All grid current effects were virtually eliminated, and the zero shift was negligible on all but the two lowest AC ranges. This latter was due to contact potential in the diode; a separate problem about which we will have more to say later on.

What was more, it appeared that a

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6SN7, which showed serious drift effects in the bridge section of the circuit, could still be satisfactory as the cathode follower/diode combination. Thus, it will normally be sufficient to purchase one new valve, preferably one of the GTA or GTB types already mentioned.

This was so encouraging that we had no hesitation in pushing ahead with the idea and adapting the remainder of the circuit to fit in with it. Although a number of problems had still to be solved we were able to do this without involving any drastic or expensive circuit changes. In fact, our total number of parts added was one valve, one switch wafer, and few resistors. These, plus an evening's work, should be all you require to bring your old instrument up to date.

METER REVERSAL

The first problem was that of reversing the meter action to cope with the "-DC" and "AC" positions, the output from the rectifier being negative with respect to the circuitry for the normal DC ranges.

We achieved this in the original instrument by simply feeding the signal to the grid of the opposite valve, but, with only one cathode follower input stage, this was no longer possible. The alternative was to reverse the connections to the meter, as we did in the Senior VTVM, and this seemed to be the best solution.

Unfortunately, we could not avoid adding another switch wafer for this function, but this is not unduly difficult. There is plenty of room for the extra wafer, and this may be all that is needed if the shaft is long enough to accomodate it. If not, the junk box may yield another clicker plate assembly, which can be pressed into service. Even if a complete new switch has to be purchased we feel that the outlay is justified.

Much of the remaining switch wiring remains unchanged, except that it directs the input voltage to the grid of the cathode follower rather than the bridge valve. The switching associated with the voltage and ohms range selection remains as before.

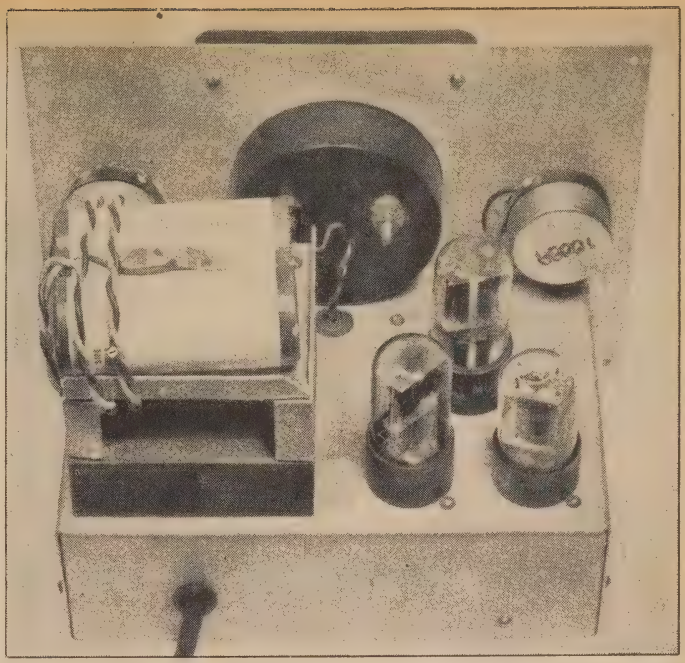
The cathode follower requires a low voltage supply symmetrical with respect to chassis, that for the cathode being negative by the same amount as that for the plate is positive. This is provided quite simply by the addition of two 4,700 ohm resistors to the voltage divider network already across the last electrolytic.

We found it most convenient to support the entire voltage divider network on two 4-tag terminal strips, one mounted on the rear and one on the side of the chassis. These are clearly visible in the accompanying photograph. Although 2-watt resistors are required for the higher values, 1-watt types are adequate for the 4,700 ohms in each case.

CONTACT POTENTIAL

The next problem concerned the contact potential effect in the diode rectifier used for the AC ranges. This is an effect whereby a small amount of current flows from cathode to plate of a diode, even when no obvious potential is applied to the plate. In this case it develops a small voltage across the diode load, which ultimately appears as a false reading on the AC ranges.

The voltage indicated is not very high —about .6 volt is typical—and so is of little consequence except on the 3-volt



This rear view shows the additional 6SN7 in the socket which previously held the 6H6. In most cases a 6SN7 unsuitable for use in the bridge portion of the circuit will perform quite satisfactorily in this position. A 6SN7GTA or GTB will probably give best results in the bridge section, but the job of this valve is now much easier.

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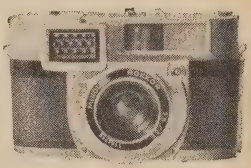

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and 10-volt ranges. What is more important, it is a true zero shift not effected by the loading imposed by the external circuit. Thus it is only necessary to check and reset the zero on these two ranges in order to ensure accuracy.

In the case of the Senior VTVM we overcame this problem by the use of two diodes, one in each half of the bridge, plus an additional switching network to maintain approximately balanced resistance in each cathode follower grid. This is completely effective, but once again involves circuit complexity out of proportion to the style of the instrument.

USEFUL IMPROVEMENT

However, we were able to effect some improvement invovling only a very simple addition to the circuit. It is by no means a complete cure, but appears to be justified if only by reason of its simplicity.

Basis of the scheme is to bias the cathode of the diode slightly positive to offset the contact potential and, in fact, it is perfectly feasible to carry this idea to the point of complete cancellation. Unfortunately this effects the linearity of the lower ranges, but it is possible to strike a worthwhile compromise between the two requirements.

If the bias is adjusted to reduce the reading from .6 to about .3, or even .25, the non-linearity introduced is still of a very low order. On the 3-volt range this reduces the zero shift from 20 p.c. to 10 p.c., not enough to be ignored, but a help nevertheless.

On the 10-volt range the shift is reduced from 6 p.c. to 3 p.c., bringing it well within the accepted tolerance range for most AC meters. Thus, except for very precise measurements, we may consider that this scheme reduces the ranges involved from two to one.

The bias network consists of a 47K resistor and a 220 ohm resistor forming a voltage divider between the positive HT point and chassis, the cathode being connected to the junction. In order not to upset the wiring of the probe socket, the 220 ohm resistor is mounted in the dummy plug. There is just room for a half watt type if the threaded portion of the plug cover is filed about 1/8in.

It may be necessary to experiment a little with the 220 ohm value, the main thing being to reduce the shift by the amount already suggested. Variations in other component values, as well as the characteristics of the diode itself, will have a bearing on the final value.

CALIBRATION

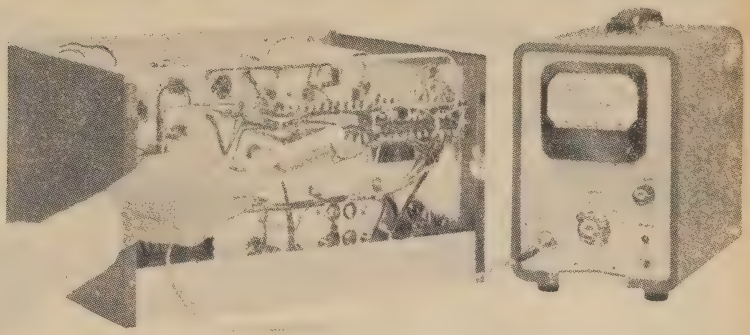
Quite naturally, all these alterations will have some effect on the "Cal. Adj." settings, and it will be as well to go right over this phase of calibration. As before, a single setting is all that is required for the DC ranges, while, in theory at least, separate settings are required for each AC range to compensate for the differing charactristics of the diode rectifier with different values of applied voltage.

In the case of the 6H6 this was also true in practice, but the 6SN7 appears to be better in this respect. Presumably due to its greater efficiency, we found we needed special settings only for the 3-volt and 10-volt ranges, with a third setting for the 30, 100 and 600 volt ranges.

These settings should progress logically in an anti-clockwise direction. If they occur erratically, it probably indicates long term drift in the close tolerance re-

(Continued on Page 127)

A CLIP-ON DC MILLIAMMETER



The meter is used merely by clipping the probe around the conductor. Ranges are from 1 ampere to fractions of a milliamp.

The Hewlett-Packard Company of California have recently announced a sensitive multi-range instrument developed from the well known clip-on ammeter. The following article by Company Engineers indicates the potential value of this new type of electronic clip-on milliammeter for general circuit testing.

IN typical electronic work, direct currents are ordinarily measured either by measuring the current directly with a moving-coil type current meter or by measuring the voltage drop across a known resistance in the circuit.

Although each of these methods has a long tradition, each also has substantial disadvantages. In the case of the indirect method with a voltmeter, the measurements are most often made across resistances having tolerances of 10 per cent to 20 per cent, so that a minimum ambiguity of this same amount also exists in the current value obtained. Frequently, this ambiguity leads to selection of non-optimum component values with later difficulties.

In the case of the direct method with a moving-coil instrument, the circuit must be opened and the current meter connected therein. This is an inconvenience that in practice often results in omission of the measurement with subsequent erroneous deduction and wasted effort.

METER RESISTANCE

Additionally, in the continually growing field of low-impedance circuits, where the current parameter assumes greater importance as in transistor work, the resistance of the moving-coil instrument is sometimes intolerable.

A new and much-easier-to-use current-measuring instrument that overcomes the foregoing objections has been developed in the form of a clip-on DC milliammeter which, as far as is known, is the first instrument of its type to be brought to production status.

It makes the measurement of direct currents in low- as well as high-impedance circuits as easy as a measurement of voltage, and at the same time covers the whole range of currents encountered in such work—from a fraction of a milliampere to 1 ampere in six ranges.

Further, and especially valuable in the transistor field, it introduces no DC loading into the circuit being measured. Currents in low-impedance transistor circuits can thus be measured without disturbing static operating conditions. Also, the presence of alternating currents normally causes no error in the direct-current readings.

The instrument consists of a clip-on probe with associated electronic circuitry and indicating meter located in a small cabinet. The probe has been constructed in the pen-holder style in which flanges on the probe body open a set of split jaws for clipping around the conductor to be measured.

SIMPLE MEASUREMENT

In typical practice the instrument can measure direct current in nearly any instance where a ½-inch length of conductor is available for the probe to clip around. Measurements can be made adjacent to a tube socket terminal, on transistor leads, on a conductor of a laced cable, and even on small composition resistors.

At the same time remarkably few measuring precautions are required. Mainly it is merely necessary to insure that the probe jaws are closed and are free of gap-causing particles, a condition which is easy to test for, since improper closure is indicated by a large earth's-field reading on the low range.

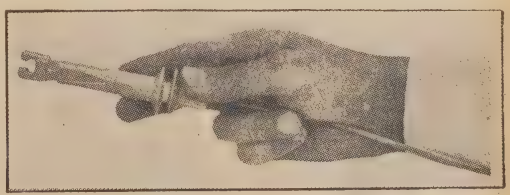
The new milliammeter operates by sensing the strength of the magnetic field produced by the current being measured. Since this sensing extracts no energy from the field, the milliammeter has the unusual property that it introduces no resistance (and very little inductance—less than 0.5 microhenry) into the circuit being measured.

Freedom from loading is, of course, always desirable in a measuring instrument, but in transistor work where low-impedance circuits are common this property is especially valuable.

In some uses such as searching for shorts, it is desirable to know the direction of current flow. The sensing elements in the probe are such that current direction can be determined, and the probe itself is marked with an arrow that shows current direction for an upscale reading. Connecting the probe on the conductor in the reverse orientation causes the meter pointer to move downscale but has no damaging effect on the instrument.

The probe contains a specially developed magnetic amplifier which provides an AC output proportional to the magnetising force produced by the measured direct current. The AC output is amplified and applied to a phase-sensitive detector whose output in turn feeds an indicating meter. The overall system, including the magnetic amplifier, is stabilised with 40db of feedback for good, long-term performance.

The AC signals produced by the magnetic amplifier in the probe occur at low levels so that the amplitude of the sig-



Probe jaws are opened by handle flanges. Spring return closes them.

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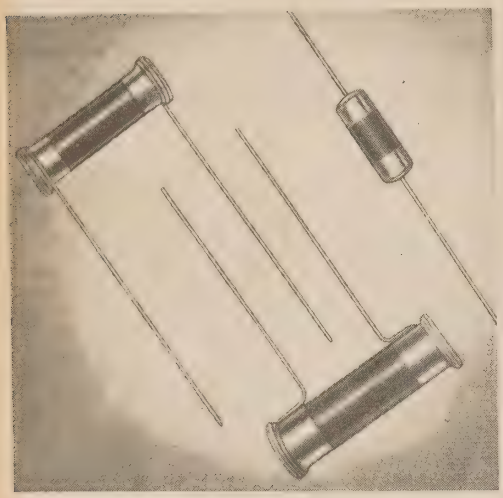

TYPES AND RATINGS					
Brimistor Type.	Maximum Continuous Running Current.	*Lamp Wattage.	Resistance at 20° C.	Resistance at Maximum Current	Retail Price.
CZ9A	1.0A	150 W.	350	3.7	2/11
CZ11	1.5	250 W. or 300 W.	140	2.5	5/3
CZ12	2.5	500 W.	120	1.5	6/8

* These figures apply to lamps operated on the 200 to 250 volts supply; however, Brimistors may be used at lower voltages if the maximum continuous current is not exceeded. For example, the CZ11 could be used with a 110-volt 150-watt lamp.

GENERAL INFORMATION

The resistance of a projector lamp filament increases many times with temperature. Thus at the instant of switching on, when its filament is cold, its resistance is low and a very high surge current will flow for a fraction of a second. To avoid this undesirable surge, a Brimistor should be fitted in series with the projector lamp. Brimistors have a large negative temperature coefficient, so that their resistance falls as they warm up. Thus at switch-on, the current through the projector lamp is limited by the cold Brimistor. As the Brimistor warms up its resistance rapidly falls so that after a short time the full supply voltage is applied to the lamp, giving good suppression with the minimum of delay.

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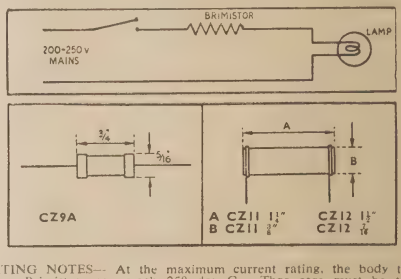

OPERATING NOTES.—At the maximum current rating, the body temperature of a Brimistor may reach 250 deg C. Thus care must be taken in mounting to avoid damage to adjacent components.

Since Brimistors operate by self-heating, it is important to ensure that they are not cooled by the fan when one is fitted to the projector.

At least ½in lead should be left free when connecting into circuit. Brimistors are made of a rather brittle material and will fracture if dropped or subjected to severe mechanical shocks; they should, therefore, be handled with care.

After switching off, ten minutes must be allowed for the Brimistor to cool down before switching on again if good surge suppression is required. However, if you do switch on again almost at once, you are doing no worse than you would without a Brimistor.

Brimistors must not be operated in parallel.

K107

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nal coupled into the measured circuit is slight. No specification for this amplitude has as yet been firmly established for production instruments, but experience to date indicates it will be about 1/100 volt peak.

The signal frequency has been selected to lie at a little-used region—40 kc — so that only rarely will the operation of the instrument be affected by the presence of this frequency and its harmonics in a circuit being measured. The presence of a frequency within about 20 cycles of 40 kc and its harmonics in the measured circuit will be indicated by a beat in the meter reading.

HIGH SENSITIVITY

On the instrument's most sensitive range (3 milliamperes full scale) readings can be made down to a minor division (0.1 ma) or so from the bottom of the scale, since the ultimate limitation of Barkhausen noise causes less than half a division reading at the bottom of the scale.

In many cases, however, even higher sensitivities can be obtained by looping the conductor being measured through the probe two or more times to increase the effective magnetising force of the current. Scale readings should then be divided by a factor equal to the number of turns made in the conductor.

The sensitivity can be increased in this manner until reverse-coupled voltage becomes a limiting factor. Each additional turn will add the amount of reverse-coupled voltage described above for one turn. Even here, though, it should be noted that measurements can often be made at points in the circuit where a circuit capacitor will bypass the voltage, which is essentially 40 kc in composition.

In order to make the instrument suitable for measuring small currents, considerable care has been taken to minimise the effects of external fields on the probe elements. The effect of external homogeneous fields is minimised by a balanced arrangement for the probe elements.

In practice, the chief homogeneous field to be dealt with is the earth's field, but it is interesting to note that from the standpoint of small-current measurement the earth's field is relatively very strong. One way of illustrating this point is to note that the earth's field is roughly the same as the magnetising force produced in the probe magnetic circuit by a conductor carrying 1 ampere.

EARTH'S FIELD

The construction of the probe is such that no effects can be noticed from the earth's field other than on the most sensitive range. With the instrument set to this range, the most adverse changes in probe orientation will cause a shift in zero reading of less than plus or minus 1 minor division, an effect which can then be compensated for any one orientation by adjustment of the zero control.

A high degree of shielding against non-homogeneous fields is also provided so that measurements are essentially free from effects from currents in nearby conductors.

Typically, a current of 1 ampere flowing in a conductor so close that it is touching the probe will produce an effect amounting to only about 3 per cent of the most sensitive range, while if the conductor is 1 inch away the effect is scarcely perceptible.

Rated accuracy for the instrument is plus or minus 3 per cent or full scale plus or minus 0.1 milliampere. This is an overall rating that includes the effect of operating the instrument from line voltages up to plus or minus 10 per cent from a 115-volt centre value, of meter movement tolerance, of temperature over normal room ranges, etc.

The rating also applies when AC currents exist in the circuit being measured as long as their peak value does not exceed the full-scale value of the range used, and as long as they are not near 40 kc, as discussed earlier.

The magnetic sensing elements in the probe are sufficiently free of remanence or residual induction effects that residual readings are not obtained in the normal course of measurements.

If, however, large overloads of many amperes are applied, such as from shorts in a measured circuit or rapid discharge of a capacitor, residual readings will result, and for this contingency a degausser is included in the instrument. The degausser is activated by a momentary contact switch, which in use is manually held closed while the probe is withdrawn from the degausser aperture. On cabinet style instruments the degausser is located at the back of the cabinet and on rack instruments at the front.

GENERAL USE

A note is also in order concerning the general usefulness of the instrument since, although it was developed with low-impedance work principally in mind, it has turned out to be extremely useful in the general course of electronics work in higher-impedance circuits as well. It is useful for searching out shorts, checking tube electrode currents, checking power supply currents, and simply measuring currents for any number of purposes.

It has also been found very useful in production work where, with some advance programming of data for technicians, it becomes valuable for checking currents both in ensuring proper operation of production equipment and in trouble-shooting.

(Arndt Bergh, Charles O. Forge, and George S. Kan.)

FURTHER NOTES ON R-C BRIDGE

(Continued from page 55.)

use of a 6U8 as the bridge amplifier, the two stages being capable of very high amplification. High-gain twin triodes will work almost as well, however, if you happen to have one on hand. The 12AT7 and the 12AX7 are both quite satisfactory but the 12AU7 is noticeably down on gain, the null being less clearly defined.

In wiring the range switch, particular care should be taken to isolate the jumper wire which bridges four lugs on each bank and then joins to one of the external terminals. Keep it away from the chassis and do not rest any of the other wiring against it. By the same token, do not be tempted to use the type of switch on which the two sets of lugs are mounted on a single wafer.

With care along these lines and with the instrument installed in its metal case, the bridge should balance at about 3pF on the 100pF range, with nothing connected between the "unknown" terminals. Very close accuracy can thus be obtained on low capacitance values by subtracting this minimum reading from the indicated value.

On all other ranges, it is too small to be of any significance.

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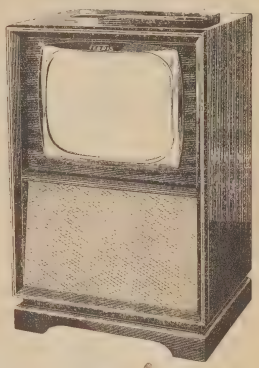

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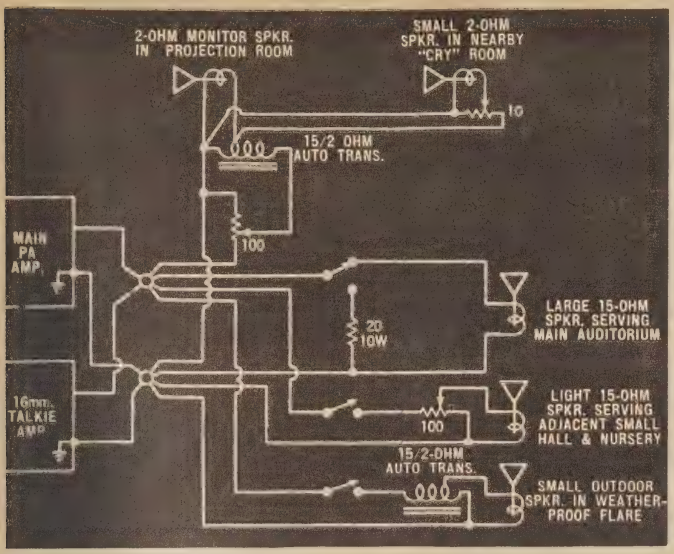
2-OHM MONITOR SPKR. IN PROJECTION ROOM
SMALL 2-OHM SPKR. IN NEARBY "CRY" ROOM
10
15/2 OHM AUTO TRANS.
100
MAIN PA AMP.
20 10W
LARGE 15-OHM SPKR. SERVING MAIN AUDITORIUM
16mm. TALKIE AMP.
100
LIGHT 15-OHM SPKR. SERVING ADJACENT SMALL HALL & NURSERY
15/2-OHM AUTO TRANS.
SMALL OUTDOOR SPKR. IN WEATHER-PROOF FLARE

A typical system of speaker wiring which was adopted by one suburban church to meet its own particular needs. Requirements will differ but working compromises like this can be struck to make the best use of equipmnt on hand.

More About Amplifiers For Churches, Etc.

The first part of this article, last month, on the subject of amplifier systems for churches, was devoted largely to a discussion of speakers, microphones and their placement for best results. This concluding portion of the article has more to say about speaker wiring, the amplifier itself and suitable locations for same.

AS indicated last month, it is usually quite practicable to extend the wiring for a 15-ohm voice coil circuit over the distances likely to be involved in a church installation. By using twin plastic flex, VIR or tough rubber covered electrical type wiring, the DC resistance of quite long runs can be kept well below 15 ohms.

FAULTY JOINTS

All joints and connections must be properly soldered, however, because one faulty twisted or screwed connection can offset any amount of care in other respects.

If the amplifier happens to have a 15-ohm secondary winding, therefore, it is quite practicable to run leads to a 15-ohm loud speaker voice coil at a remote point in the auditorium or out-of-doors, or to a series-connected group of speakers presenting the same order of impedance.

A likely problem about a 15-ohm circuit is the difficulty of feeding monitor or other subsidiary low-level speakers, because nearly all the small speakers likely to be used for such tasks are fitted with 2-ohm voice coils.

It is very rarely a satisfactory solution to feed such speakers through resistors from the 15-ohm line, because unnecessary loading is imposed on the amplifier output and more audio power is likely to be wasted as heat in the resistor than is used by the speaker.

There are three possible ways of avoiding or minimising such wastage of audio power.

The first is possible if the output transformer on the amplifier has a tapped secondary winding. The one shown on the amplifier, last month, is a high fidelity type which automatically has a 3.75-ohm tap available when the two sections of the secondary are wired in series, as per maker's instructions, to give 15 ohms overall.

TAPPED SECONDARIES

Alternatively, some currently available "medium fidelity" or "public address" type output transformers have multi-tapped secondaries which make it easier to feed low resistance voice coils.

Thus, if one or more small speakers is fed through a low resistance potentiometer (say 10 to 20 ohms) from a low impedance tapping, the wastage of audio power is greatly reduced.

A second possibility, where two or more subsidiary speakers are to be used, is to wire them in series. By thus raising the impedance of the group, they can be fed from the main speaker line through a resistor, with that much less wastage of power.

Better still, both the foregoing ideas can often be combined, the subsidiary speakers being wired in series and then connected as a group across as much of the secondary as will give the required order of output from them.

The output level from individual speakers in a series string can be manipulated to some extent by using more or less sensitive types, as required, or by adding small series and shunt resistors at the speaker to reduce level, while still maintaining the net impedance at a nominal 2 ohms.

If need be, any one speaker can be cut out of circuit with a two-way switch, so wired that it replaces the voice coil with a 2-ohm resistor or thereabouts. By this means, individual speakers in a series network can be cut in or out of circuit without greatly affecting volume level from the others.

AUTO TRANSFORMERS

A third and very satisfactory method of operating low impedance speakers is to fit each one with an auto-transformer, connecting the whole winding across the 15-ohm line and the speaker voice coil across only a selected small portion of the winding.

By such means virtually no power wastage is involved and, further, if auxiliary volume control is required, it can be effected by using a 100-ohm potentiometer to introduce the winding across the line. (See diagram page 73, last issue.)

by Neville Williams

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Suitable audio transformers have been available commercially but can be hand-wound on an old choke or transformer core, with a centre leg dimension of not less than about ¾-inch square.

Wind on 50 turns of 19 or 20 B&S gauge enamelled wire, establish a tapping, then add another 87 turns to make a total of 137. This will give an exact 2 to 15 ohms ratio, using 50 turns for 2-ohms and 137 for 15-ohms.

A greater step-down will allow the subsidiary speaker to operate at lower volume and with less reflected loading on the amplifier. This can be effected by connecting the subsidiary speaker across fewer turns than 50 of the total 137 or, alternatively, retaining 50 turns as the tapping point and extending the whole winding beyond 137 turns to the limit of the window area.

OPTIMUM LOAD.

As with the 500-ohms case discussed last month, an effort should be made, once the nature of the speaker wiring has been determined, to see that the amplifier is working into its optimum load resistance or a slightly lower value with all speakers in circuit. This will ensure that maximum power output is available on peaks for full load conditions.

Provided the amplifier incorporates negative feedback, any subsequent increase in load resistance, brought about by switching speakers out or turning down volume controls will not greatly affect the volume in the remaining speakers.

In this connection, a point which is not always appreciated is that with ordinary multi-tapped transformers, the primary reflects its rated load when any ONE of the secondary tappings connects to a voice coil or load of the same nominal value.

For example, a 10,000-ohm transformer would reflect this value of load with a 15-ohm voice coil across the whole secondary OR an 8-ohm voice coil across the 8-ohm section, OR a 3.5-ohm voice coil across the 3.5-ohm section OR a 2-ohm voice coil across the 2-ohm section.

PARALLEL SPEAKERS

Connecting the two such speaker loads simultaneously would halve the reflected primary load, just as would happen if two 15-ohm voice coils were connected in parallel across the 15-ohm winding.

If the requirement calls for several speakers operating simultaneously from the one winding, each one should be tapped across a smaller section than normal of the winding to preserve at least some semblance of correct matching.

Thus two 15-ohm voice coils in parallel should connect across the 8-ohm section of the winding. Alternatively, a 15-ohm and an 8-ohm speaker, both to draw full power, should be connected respectively across the 8-ohms and 4-ohm sections. If 2 ohms is the lowest tapping on the transformer, it may be possible to minimise loading on this section by having two or more 2-ohm monitor speaker voices wired in series and fed from 2 ohms.

Of course, if some of the lower level speakers normally operate with portion of a control potentiometer in series with the voice coil, their influence on the net load will be of lesser order.

It may be difficult to be completely accurate in the matter of loading, particularly as speakers themselves are subject to wide impedance variations, but at least gross errors should be avoided.

As mentioned earlier, the use of 2-ohm speakers throughout and a 2-ohm transformer secondary is likely to be complicated by the DC resistance of long connecting leads. Fortunately the practicability can usually be predicted with the aid of wire tables. By estimating the length of wire from the amplifier to the speaker and return and referring to tables, the DC resistance of various types of wiring can be determined.

If the wiring resistance equals or exceeds the nominal voice coil impedance, it is obvious that the loss in audio power is going to be appreciable.

Th problem of feeding monitor or subsidiary low-level speakers is also likely to be complicated by the fact that the output transformer will have no tappings lower than 2 ohms. It will thus be necessary to use a series string for the subsidiary speaker, or feed them through resistors or hand-wound auto-tranformers.

POWER OUTPUT

As regards the choice of amplifier, something with an output power of around 25 watts should be adequate for a fairly complex role, as envisaged in the first of these articles. If it happens to have a little more power than this, so much the better.

Where the amplifier is to operate just one speaker in the auditorium, without subsidiary circuits, a 15-watt should be adequate for anything but a very large building.

The 17-watt amplifier (April and May 1958) and the 35-watt amplifier (March and April 1958) are typical of modern practice and would be a good choice where all new parts are to be used.

Alternatively, we showed the circuit and photographs last month of a 25-watt amplifier using 807 (or 6L6) output valves and a variety of non-critical parts, which could conceivably be collected by a church group anxious to save money where they can. Though most of the parts for the original amplifier were, in fact, collected in this way, the amplifier in question looks the part and is a very efficient unit.

AMPLIFIER UNIT

It is not proposed to detail the amplifier as a full-scale constructional project nor to issue a blueprint for the chassis. However, the general layout could be followed by anyone making up a chassis or using an existing one and trying to press into service a variety of other components.

The one important feature of the design is the successful incorporation of a 4-channel mixer on the main chassis and without any trouble from hum. This was made possible by following a very strict earthing procedure for the entire input circuit.

As indicated in last month's photograph, the microphone and pickup jacks are mounted directly on the end of the chassis, furthest from the power transformer. All earth returns to do with the EF86 preamplifiers and the 6AU6 input circuit are made strictly and only to this portion of the chassis.

The wiring is arranged so that the grid return resistors of the EF86 valves, the cathode components and the screen bypasses all return to a couple of insulated points on adjacent tagstrips. Similarly, the cathode components and all the volume control wiring of the 6AU6 is returned to insulated lugs, which are then joined together and returned to an earth point adjacent to the input plugs.

Volume control covers, which normally earth via the spindle, need not be disturbed but should not be bridged across to the earthy end of the resistance elements. As indicated by the circuit last month, these last must be returned only to the common earth point.

The 0.47meg. resistors forming the mixing circuit should be supported on tag-strips in the immediate vicinity of the potentiometers and the front of the chassis, to avoid long, high-impedance audio leads.

CONTROL WIRING

The interconnecting wiring between the volume and tone potentiometers should be run in shielded wire. The braiding can well form part of the earth return circuit but should be enclosed in nylex tubing to avoid accidental contact with the pot. covers, the chassis or earth points other than the selected one.

As a further precaution against stray hum pick-up, a bottom plate was attached to the chassis by the same screws which held the mounting feet. Similar techniques can be applied, of course, to almost any single-unit amplifier, where high-gain input circuits and an AC power supply have to be accommodated side by side.

The particular amplifier proved to be quite stable with about 20db. of feedback and operating into long speaker

---

Discussion of column speaker systems with a representative of the Rola Company has brought to light the following recommendations, which may be useful to anyone interested in experimenting along these lines:

(a) Use a 9-6H at top and bottom of column and use 9-6L's in centre.

(b) Mount the speakers on their vertical axes and leave a maximum of 2in between adjacent baffle openings.

(c) Inside dimensions of the column which should be constructed of ¾in ply are 62in high, 12in wide and 10in front to back. This size will provide good bass but the column could be reduced somewhat in size, if desired, though at the expense of low frequency response.

(d) Damping may be provided by means of a piece of ¾in hair felt 12in in width and 82in in length. This is tacked to the top of the column, allowed to drape down the back and lie on the floor of the column. No damping is needed on the front or side walls.

(e) Speaker resonances. We recommend the use of F69 cones for the 9-6L's and the F70 for the 9-6H's.

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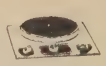

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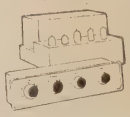

Aegis Mullard 5/10. Australian made and approved by Mullard. A very fine low-priced amplifier, now available with Stereo Control Unit.

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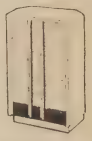

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leads. The same may not be true of all amplifiers, particularly those using a nondescript output transformer.

Before passing an amplifier as "finished," it would be very wise to set it up with all wiring and all speakers in position but with a multimeter connected across the line and set to the 10-volt AC range. If the meter shows any significant deflection, with no input signal, but with particular speaker lines in or out of circuit, it can be taken as an indication of high-frequency oscillation.

Curing the effect may involve reducing the amount of negative feedback, shunting the feedback resistor with a different value of capacitor or shunting the 6AU6 plate to earth with a larger value of capacitor. (See current articles by the Editor on this subject).

LOCATION IN BUILDING

By way of conclusion, some remarks may be helpful about the location of amplifier and possibly turntable equipment in a church building.

The least desirable arrangement is to have it set up on a seat or a table in the immediate view of the congregation. It is likely to be untidy and open to bumping or thoughtless tampering by juveniles. It may need to be put away and set up afresh every week and, last but not least, every movement by the person operating it is a source of distraction.

If no better arrangement can be made, the equipment should be housed in a self-contained cabinet or on a covered shelf in an inconspicuous position. It could conceivably be partly hidden by the organ or console and possibly controlled by the organist, who will always be on the spot to look after it.

If it is to be controlled by a separate person, remember that he must sit by it for the duration of every service or else must have unobtrusive access to it.

A more progressive approach is to examine the layout of the church behind the congregation with a view to setting aside some space to serve as a "technical centre."

The amplifying equipment can then be set up permanently in this space and provision made also for projecting still or moving pictures from an elevated platform or table, over the heads of the audience on to a screen at the front.

LIGHT SWITCHES

Permanent power and speaker wiring can be added for the purpose, and auxiliary switches can be installed, as a further refinement, so that the projectionist can control the lights without all the usual "tic-tac" signs that accompany screening in the average church.

It may be interesting to quote actual cases to illustrate possible approaches to the provision of a "technical centre" in local churches.

CASE NUMBER 1: In this rather large church, seating approximately 500 persons, floor space was fully occupied by fixed seating and passageways. However, inspection revealed a covered internal porchway over the main entrance door, with nothing but rubbish and dust on the top side.

Cleaned off and covered on the top with flooring material, it offered an excellent elevated projection platform behind the audience and several feet above their heads. A steel ladder provided ready access and there was room on top for permanent projection and amplifier equipment.

An obvious refinement was to add a light waist-height parapet, to give a degree of privacy, painted to blend with the adjacent wall.

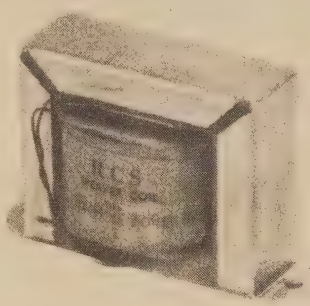
CASE NUMBER 2: This church also has an internal entrance porch but so placed as to leave a rather narrow area between one side of the porch and the side of the building. Though unattractive as a seating area and seldom used as such, it provided an excellent space, when partitioned off, for an amplifier and projection centre.

CASE NUMBER 3: A new church in which an elaborate "cry room" had been provided, rather like a glassed-in gallery behind the main congregation.

The intention is to set aside portion of this as an amplifier and projection centre.

CASE NUMBER 4: The most elaborate we have seen to date, this is a medium-sized suburban church to which, in the course of renovation, a complete new front has been added.

There was a very considerable space between the 8ft ceiling of the entrance porch and the roof gable. Provided



A commercial auto-transformer suitable for adapting speakers to "voice coil" secondary windings of different impedance. Details for hand-winding such a transformer are given in the article.

with a floor and lined, the space became a large amplifier and projection booth, with small glass-covered projection and viewing windows looking into the main auditorium.

All records, slides, filmstrips, etc., electrical equipment owned by the church is stored in this special room and a work-bench has been installed so that minor repairs and servicing can be done on the spot.

As a further refinement, a couple of electrician members have re-routed the wiring so that lighting is controlled by two duplicate sets of switches, wired in series, one in the entrance porch and the other in the projection room.

The latter are normally left on and, for ordinary meetings the switches in the entrance porch are operated in the normal way. For special functions, however, the porch switches are left on and lighting controlled from the projection room, even to the extent of cutting in a series resistance dimmer, should it be required.

While isolation of the equipment, as in case 3 and 4, does have a great deal to recommend it, it also imposes greater responsibility on the operator. Since he cannot now hear directly the speaker in the main auditorium, he must learn to judge volume level by means of his local monitor speaker.

Thus, while the monitor volume may be controllable for special requirements, it should normally be left in a predetermined setting so that the operator will unconsciously relate its level to the sound level in the auditorium and adjust the amplifier accordingly.

The accompanying diagram shows the speaker set-up which is employed in the abovementioned church. It is intended purely as an illustration of how, in a particular case, the requirements and problems examined earlier were met.

TYPICAL SYSTEM

It does not ignore impedance matching requirements, though it certainly takes liberties, to produce a system which is simple, which could use parts on hand and which meets the immediate needs.

The main P.A. amplifier — actually the one pictured last month — has an output transformer having a nominal impedance ratio of 9000/15 ohms. The secondary can therefore be loaded down to at least 10 ohms to reflect a primary of 6000 ohms, which is a reasonable figure for Class AB1 807 valves.

Again, the impedance of ordinary speakers is likely to be higher at most frequencies than their nominal value, being a further reason why it was not illogical to load the 15-ohm secondary more heavily than might at first appear.

The amplifier feeds directly to the main speaker in the auditorium but a switch is included in the line near the amplifier (in the projection room) so that the speaker can be cut out of circuit when desired and replaced by a resistor to maintain the same order of loading.

Experience with the equipment had shown that sound reinforcement in the particular auditorium was not always necessary, some preachers being equipped with plenty of natural voice. It was better in such a case to simply switch out the auditorium speaker, leaving the amplifier to feed the subsidiary speakers as necessary.

The auditorium speaker or its substitute resistor therefore provide the main permanent load on the amplifier.

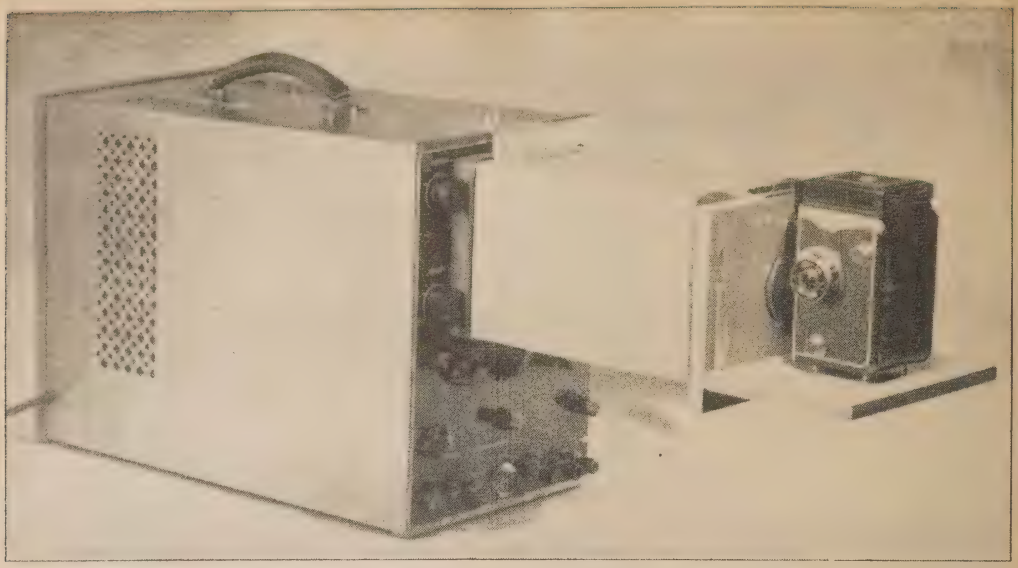
The monitor speaker in the projection booth is a 2-ohm type, fed from the 15-ohm line through a potentiometer and an auto transformer of the type described earlier. The potentiometer never needs to be fully advanced, so that only minor additional loading is imposed on the amplifier output circuit.

ADJACENT HALL

It happened to be convenient to feed the small "cry room" speaker from this same circuit but with its own local potentiometer to limit volume still further. In practice, the level required from this speaker is quite low.

Another light duty 15-ohm speaker is installed in an adjacent hall, in a position where it can be heard both in the hall and in a nursery room. The volume level required from this speaker is normally not very high, so that the gain control is seldom fully advanced. With its loading effect thus minimised, it is practical merely to switch it into circuit when needed.

(Continued on page 123)



This photograph shows how the photographic jig fits to the face of our Wide Band Oscilloscope, held in place by a single screw and wing-nut. The metal tube excludes all light from the CRO face, while the hinged rear platform holding the camera, can be swung up out of the way to allow the image to be inspected.

Taking Photographs Of CRO Patterns

Making oscillograms from a CRO screen presents a number of problems: electrical photographic, and mechanical. This article discusses these and describes the construction of an ingenious jig which takes care of most of them in a particularly simple manner. Many of the points raised will also apply to other forms of simple copying.

by

Wes Yashin

ALONG with other laboratories we frequently experience the need to make a permanent record of waveforms from an oscilloscope screen. In an emergency the rough and ready method of making a tracing from the screen had sufficed, but as a regular means of making oscillograms it is not to be recommended, since its accuracy may be doubted.

As a result, we have been resorting more and more to the photographic method of making oscillograms.

Radio and photography are closely allied fields and it is usual to find workers in the one field to have a working knowledge of the other. Hence, the production of oscillograms need not be confined to a well-equipped laboratory and any experimenter who owns a camera as well as an oscilloscope may combine the two to produce acceptable results.

In the ensuing paragraphs we propose to discuss the making of oscillograms, together with the equipment and the processing required to ensure success.

The fluorescent screen in a cathode-ray tube is a coating of phosphor which, when bombarded by electrons, produces a spot having a colour and persistence varying with the type of tube and its application.

Certain phosphors produce a highly actinic spot having a bluish fluorescence and short persistance. These types are specially suited to photographic applications.

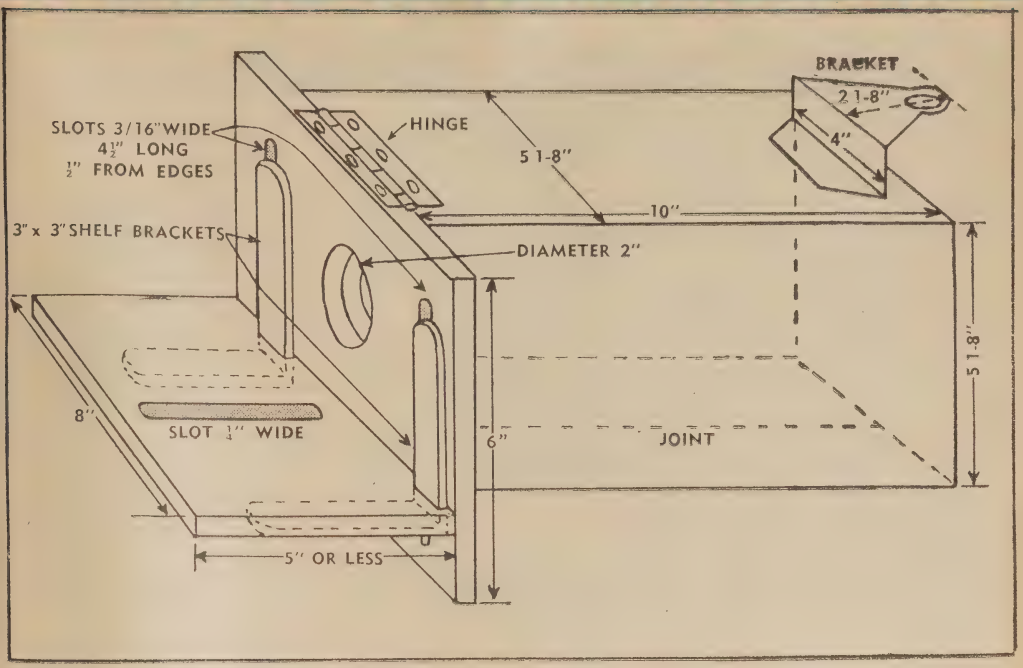
The majority of cathode ray tubes, however, use a green phosphor with a medium persistance. Since virtually all photographic emulsions have peak sensitivity in the blue region, green is a fundamentally less suitable colour. In the case of most modern panchromatic emulsions this difference is slight, but it is quite serious with the "Ortho" types of film.

In any case, the amount of light available from CR tubes is fairly limited. Although the brightness of the trace may normally be increased appreciably beyond that required for visual working, this tends to produce halo effects and, what is worse, severe lack of focusing. In view of the popularity of tubes of this kind, our discussion will be based on making the best possible use of the image they normally present.

Besides the above limitations of the tube itself, there is the problem of extraneous light on the tube face. The effect of this is either to reduce the overall contrast, or introduce patches of light in the form of reflections of windows, light fittings, etc.

It thus becomes essential to exclude

DRAWING SHOWING ALL CONSTRUCTIONAL DETAILS



These plans show the general dimensions of the photographic jig. Dimensions can be varied to suit individual requirements, the only critical one being the spacing between the CRO tube face and the supplementary lens.

this light from the tube in some manner. It may be accomplished either by darkening the entire workroom or by the provision of some form or hood on the C.R.O. itself.

The first method is quite satisfactory from a photographic point of view, but is often difficult if there are many windows or other openings to be blacked out. While justified on odd occasions, it becomes quite a chore putting up and taking down improvised screens every time pictures have to be taken. As a result, pictures which should be taken are often neglected, simply because it is too big a job to set up everything required.

INTERRUPTS WORK

A further serious objection is that other people may be working in the same room. In such cases they may have to virtually cease operations while photography is in progress — an intolerable waste of time in most cases.

On the other hand, a properly designed hood will render the operator independent of all ambient lighting conditions, or the requirements of his fellow workers. If, in addition, the hood can be made to incorporate a camera stand and all the other auxiliary equipment necessary for the job, it becomes possible to set up the camera and take the pictures, with an absolute minimum of time and bother.

From this it will be seen that there are several problems to be solved. We must be able to provide adequate exposure for the relatively low level of green light available from the screen, and without requiring a brightness level which may prejudice focus, etc.

We must provide means whereby most cameras will be able to approach close enough to the screen to make full use of the available negative area. It must be possible to do this regardless of the type of focusing system normally employed by the camera, and without the need to use a ground-glass screen in the focal plane. Fairly obviously, the latter approach becomes impossible once the camera is loaded.

We must provide a means of excluding extraneous light, yet this must not seriously restrict our view of the screen during the preliminary setting up procedure.

We need a support for the camera and which will, ideally, automatically locate the camera in the correct position for proper framing and focusing.

Let us examine these problems and their solutions in greater detail.

LIMITED LIGHT

Because the light output from our screen is low, it is essential to give a fairly large exposure to obtain a negative of suitable density. One must, therefore, use the largest aperture available, in order that the shutter speed will have some "stopping power" on the trace.

In photographic parlance this is known as using the lens wide open, the exact f. stop number depending on the design of the lens. Typical maximum apertures will vary from f 4.5 to f 2.8, the latter in the case of the better 35 mm. cameras.

Given a maximum aperture at which it is possible to use a certain lens, exposure may be varied by altering the shutter speed. The speed selected will be governed, in turn, by the speed of the film loaded into the camera.

Ideally a fast film is desirable to permit a comparatively fast shutter speed and ensure that any minor movement of the trace will not be recorded.

LOWER CONTRAST

However, the fastest films suffer the disadvantage that they produce inherently less contrast, particularly if, as is so often done, they are processed with fine grain developer.

For our present purposes, it would not appear to be necessary to follow this course. Assuming that full use is made of the available negative area, grain should not be a serious problem in work of this kind, even on 35 mm negatives. Thus, the ultra-fine grain developers, such as Microdol, Promicrol, Microphen, etc., would appear to be an unwise choice.

More vigorous developers, of the semi-fine grain variety, such as D76, Neophin Red, etc., should be perfectly satisfactory, in terms of grain, for even 35 mm negatives, and offer a worthwhile improvement in contrast.

For 2¼in square and large negatives, even more vigorous solutions, such as D72, etc., should be quite satisfactory. The main point to watch in this case is that any particular combination of

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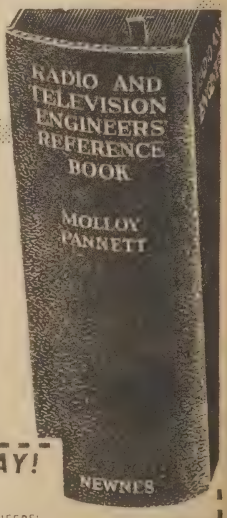

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film, developer and development time does not introduce chemical fog.

For the reasons already discussed, there does not appear to be much point in using fine grain films, and the slower speed has obvious disadvantages. However, such films as FP3, Verichrome Pan, KB21, etc., may be used with some restriction if they happen to be all that is available. Much will depend on the maximum aperture available.

It may also happen that a few shots of this type will be included in a roll carrying more normal subjects, and will have to be content with the processing demanded by the greater portion of the film. These "normal" conditions may serve as a good basis for experiment, and the following typical figures will provide a good starting point.

FP3, processed in an ultra-fine grain developer, will require about 1/10 second at f 3.5, using the brightest practical image obtainable from a 5BP1 in a typical circuit.

FASTER FILMS

HP3 or Tri-X are a little more than twice as fast, and could safely be given 1/25 second under similar conditions. However, the use of more vigorous developers and increased development should make it possible to at least double the effective speed of the film, with a corresponding decrease in exposure.

Quite naturally, these figures are intended solely as a guide. The individual worker will need to make his own experiments to allow for minor variations, such as shutter speed, light losses in the lens, methods of processing, etc., and which, if additive, can be significant.

In the foregoing discussion on processing and grain it was assumed that the image could be made to fill the greater portion of the negative area. This implies, in turn, that the camera may be focused close enough to achieve this. All but the simplest types of cameras have some focusing facilities, and the majority will focus down to about three feet.

FOCUS PROBLEMS

Focussing is achieved by altering the distance from the lens to the film surface. As the subject is approached, the distance is increased and vice versa. As the camera is brought closer to the subject a point is reached where it is no longer possible to focus, due to the mechanical limitations of the focusing mechanism. This will be true of most cameras, except a few equipped with multiple extension bellows.

Cameras fitted with interchangeable lenses—mostly focal plane shutter types—can usually be adapted for close-up working by substituting a suitable lens. In some cases the view-finder operates through the taking lens, so that the exact effect can be clearly seen. In other cases a range-finder may be used, with compensation applied automatically when the correct type of alternative lens is fitted.

Less expensive, and, therefore, more popular, types are those intended for use with one lens only, equipped with between the lens shutters, and designed to focus to about three feet. Actual focusing may be achieved by means of a range-finder (coupled or independent), a "twin" lens with ground glass, or simply a graduated scale. Whatever is used, its limitations are normally the same as those of the focusing mechanism.

Three feet is much too far away to provide any kind of useful CRO image. Using a 5in screen, 18in is about the greatest distance which gives any kind of useful image, and then generally on the assumption that the best possible use must be made of the rather small image which results. Fine grain processing is almost essential, particularly with 35mm. negatives.

To make full use of the negative area, it is essential to work down to about 10in, with even shorter distances for smaller screens.

The easiest way to bridge this gap is by means of a supplementary lens, sometimes known as a "portrait" lens. Suitable lenses are readily available from optical suppliers and, singly or in combination, may be made to accommodate almost any reasonable distance. They cost about 15/ each.

WORKS WELL

In theory, at least, supplementary lenses do terrible things to the carefully worked-out corrections of the high quality anastigmats used in modern cameras, and many enthusiasts tend to hold up their hands in horror at the mere mention of such devices.

However, for work of this kind, such objections are essentially academic. Whatever form the losses take, they certainly don't show up in the finished picture. On the other hand, the supplementary lens is a simple and inexpensive way to adapt an ordinary camera to do a special job.

Selecting a supplementary lens to do a particular job is not difficult. Having decided on the distance at which the camera needs to work—10in in this case—we simply select a lens which has this focal length.

When such a lens is placed in front of another lens, focussed at infinity, the combination will focus at a distance equal to the focal length of the supplementary, i.e., 10in. This holds true regardless of the focal length of the camera lens, or the distance (within reason) between the supplementary and camera lenses.

EXTRA LENS

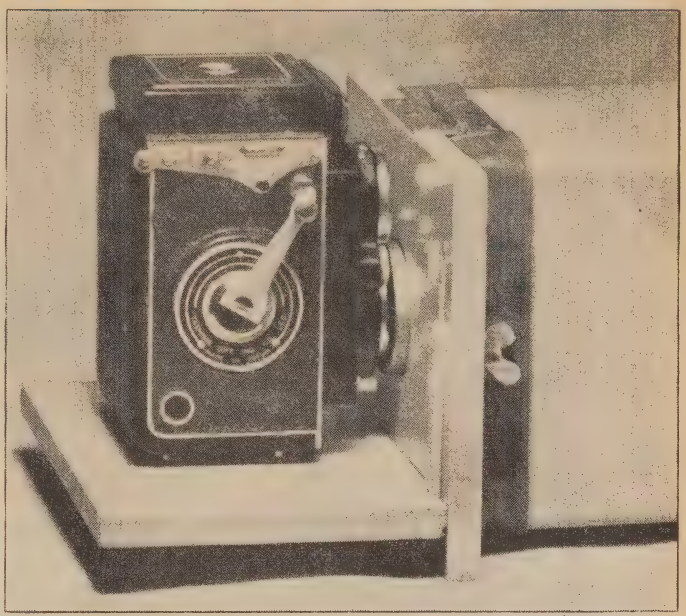
From this it may be realised that all we have to do is to fit a suitable supplementary lens permanently to the hood in such a way that it is always the correct distance (i.e., its own focal length) from the screen. Once this is done, we can use any camera with it, without any focussing worries, by simply setting the latter to infinity.

(By focussing the camera to shorter distances, we can approach still closer, but there is much to be said for selecting a suitable supplementary for use with an infinity setting, since this is the easiest setting on the focussing scale to reset with complete accuracy.)

Most large photographic supply stores will be able to supply such a lens, at least to order, while optical supply houses

(Continued on Page 87)

CAMERA IN POSITION ON JIG



Another view of the CRO attachment. Note that the camera platform can be raised or lowered to support any likely camera with its lens lined up with the supplementary lens and CRO tube face.

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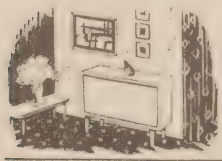
4-way, quadruple radiator Full-range High Fidelity Loudspeaker System, Walnut finish.

Attractive range of enclosures . . . .

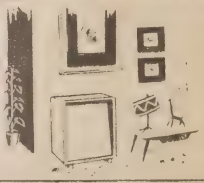


MODEL 15 4 *(Illustrated)*

This 4-way quadruple radiator Full-range High Fidelity Loudspeaker System is characterised by exceptional smoothness. Entirely new Enclosure design, wax polished in selected Walnut veneers.

SHERWOOD 2

The SHERWOOD 2 is a balanced 3-Radiator Twin Unit Full-Range High Fidelity System. Enclosure as SHERWOOD 1.



SHERWOOD 1

A balanced 2-Radiator SINGLE Unit Full-Range High Fidelity System. The Enclosure is wax polished in selected Walnut veneers.

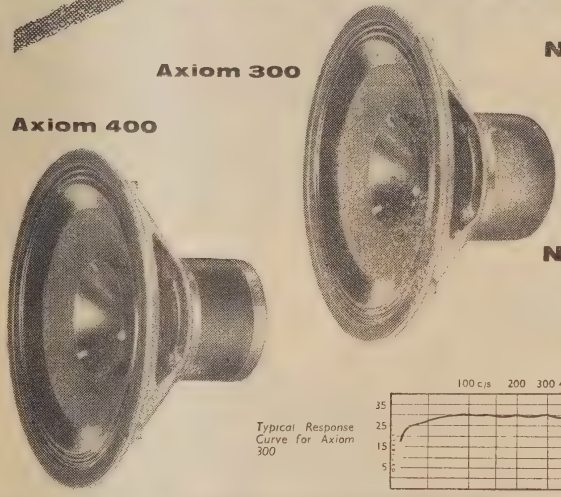
SHERWOOD 3

Balanced 3-way Full-Range, 30 c/s to 16,000 c/s, High Fidelity Loudspeaker System in Sherwood Enclosure. Overall range divided between three specially developed precision built units

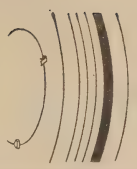
Fidelity

Axiom 300

Axiom 400

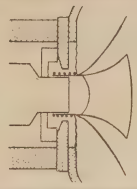


NEW



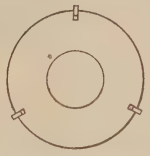
PLASTIC TREATED BASS DIAPHRAGM SUSPENSION provides correct termination to eliminate standing waves and edge resonances.

NEW



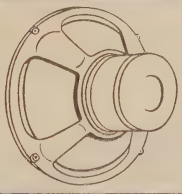
LONG ALUMINIUM VOICE COIL combines low mass for extended high frequency operation with constant "turns in the gap" at high bass amplitude.

NEW

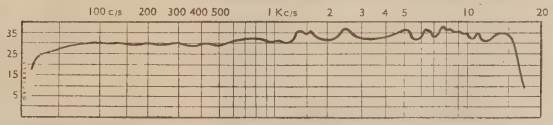


FOAM TERMINATED TWEETER CONE for prevention of spurious resonances.

NEW

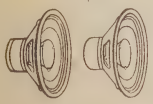


CHASSIS DESIGN gives maximum open area combined with immense rigidity and freedom from ringing.

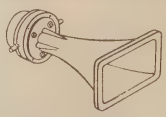


Typical Response Curve for Axiom 300

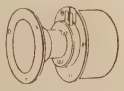
With these features . . .



UNDISTORTED BASS
Superb transient response, achieved by use of powerful magnets, correct loading, and precisely controlled low resonance with plastic suspension.

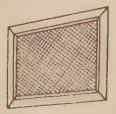


UNDISTORTED MID-RANGE
Achieved by all FOUR Systems. In Sherwood 1 and 2 by mechanical crossover and Auxiliary Diaphragm; in Sherwood 3 and the 15/4 by electrical crossover, in conjunction with latest Mid-Range pressure driven Horn Loaded Unit



UNDISTORTED TREBLE
Cleanly radiated high notes, by virtue of newly developed twin cone design in Sherwood 1. Sherwood 2 and 3 both employ tailored High Frequency Pressure Driven Horn loaded units. The new 15/4 system utilizes two such units positioned to give maximum coverage

MULTI-RADIATOR SYSTEM
All Enclosures and Units designed to give lowest distortion full range reproduction.



COMPACT SIZE
Achieved by exclusive patented A.R.U. design. No other system gives such efficiency in relation to size.

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RH/12/58

TV
TEST INSTRUMENTS

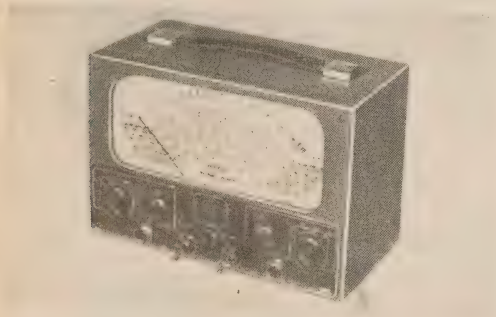
The three essentials for good TV service

by

UNIVERSITY-GRAHAM

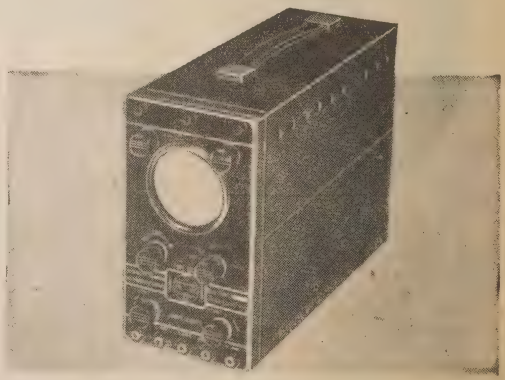
Model TVR/SM (at right)

The Model SM, combined sweep and marker generator, has been specially developed to simplify the exacting task of aligning the tuned circuits of TV receivers. Used in conjunction with the University C3 or C5 or similar oscilloscope the actual shape of intermediate frequency and overall selectivity curves is made clearly visible. The model SM provides an RF signal which is made to sweep several megacycles either side of the centre frequency selected by the tuning dial and range switch. 4 tuning ranges are on fundamentals to avoid spurious signals or beats. A crystal controlled 5.5 mc/sec. oscillator is also included to provide two simultaneous marker indications and to provide a means for accurately checking the tunable marker



Model TVR/EV (above)

This University Electronic Voltmeter offers many new outstanding features and is a basic measuring instrument for every branch of electronics. It offers accurate measurement of DC voltages, AC voltages, very wide resistance ranges and RF volts



Model TVR/C3 (above)

This Cathode Ray Oscilloscope 3 inch, although small in size, contains the features of larger instruments, is flexible in use and offers many new features. It is suitable for the visual alignment of TV receivers and direct access is possible to both horizontal and vertical plates for examination of strong voltages. It can be supplied with a demodulator probe for signal tracing work in TV chassis. Vertical amplifier response plus or minus 1 db from 15 cycles to 150 Kc and 6 db down to 1 megacycle.

Write for free illustrated literature of the instruments that interest you

UNIVERSITY GRAHAM INSTRUMENTS PTY. LTD.

5 NORTH YORK STREET, SYDNEY. BU3169

will probably be able to supply from stock, and, as is usually necessary, cut it to a diameter to suit the individual's requirements.

We obtained ours from Esdaile and Sons Pty. Ltd., and this firm was most helpful in making available a number of lenses to assist us in our early experiments. The one we finally chose had a focal length of approximately 10in.

However, it is not usual to refer to these in terms of focal length. The term "diopter" is the one normally used, the diopter being the reciprocal of focal length in metres. Thus, a positive 1 diopter lens will have a focal length of one metre, a 2 diopter half a metre, and so on. Taking the metre as 39.37in, a four diopter lens will have focal length just under 10in, which is ideally suited to our purpose.

TYPE OF LENS

When ordering simply specify a positive four diopter supplementary lens, together with the diameter to which you require it to be cut. This, of course, assumes a nominal 5in diameter CRO screen. For smaller screens, it will be necessary to work still closer, and a five or six diopter may be required.

Most such lenses are of the concavo-convex type, i.e., saucer shaped, in which case they should be used with the concave surface facing the camera.

Now for some constructional notes. As the prime purpose of the hood is to exclude extraneous light, it had to take the form of a tunnel of adequate dimensions to enclose the screen area.

Two types of oscilloscopes, described in our magazine, have been in use by our readers. The Standard 5-inch CRO appeared in several issues and in a number of versions and, more recently, the Wide Band CRO has enjoyed considerable popularity.

The position of the controls in relation to the edge of the panel and of the screen differs slightly in the two instruments, but, with a little care in sizing and fitting, full use of the controls can be retained with the hood in position.

In the Wide Band CRO, the Shift, Focus and Intensity controls were moved out a trifle to clear the visor and will therefore clear the new hood without any great difficulty. You can please yourself whether you dispense with the original visor or make the hood to slip over the top of it.

LESS CLEARANCE

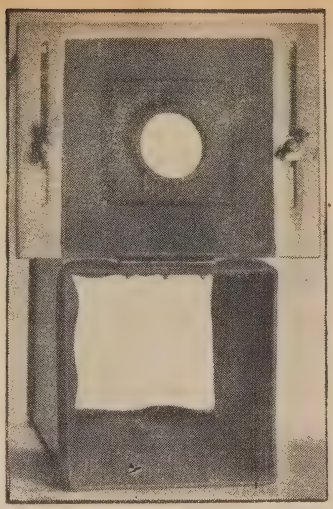
With the older instruments, the clearance between the knobs is somewhat less. It may be possible to retain use of the pointer knobs, however, by cutting the hood dimensions to a minimum and/or by filing the mounting holes to shift the controls out a little.

Failing this, ordinary small round knobs could be substituted.

Some CRO's have a dark green perspex graticule in front of the tube face, but this may have to be removed when photographing, as it will reduce the light output.

Assuming the use of a four diopter lens, the length of the tube will need to be 10 inches. The remaining dimensions are quite flexible and may be altered to suit the particular CRO on hand. We suggest it be made from 16g. aluminium.

When folding, the best position for the join is on the lower wall of the tunnel. A simple butt joint, reinforced by a strip of aluminium and held by rivets or by 1/8in nuts and bolts, is quite adequate.



With the camera platform swung out of the way, the CRO tube face is immediately visible. Note that the inside of the metal tube and the rear of the lens mount is blackened.

To suspend the assembly over the face of the CRO we attached a stepped bracket, terminating in a ¼ inch hole.

In the position to correspond to this hole, drill an identical hole in the top of the CRO case to take a ¼-inch bolt, which will act as the support for the hood assembly. This bolt is anchored permanently in place with a nut, while the hood, when suspended, may be held by a wing-nut.

RUBBER PACKING

A length of weather strip rubber pushed over the edges of the tunnel will ensure a light-tight contact with the panel and prevent scratching as well.

While a hood alone could serve a useful purpose by excluding extraneous light, its usefulness is further enhanced by the addition of the lens panel and platform to carry a camera.

Our finished effort is simple yet effective. A ¼ inch plywood board wider and longer than the hood, is attached to the top face of the hood by means of a hinge about 2½ inches long. On each side of the board, one half-inch from the edges, we cut two parallel slots. These slots must have just sufficient clearance for a 3/16-inch bolt.

The camera supporting platform is of ¼-inch plywood and has 3 x 3 shelf brackets attached to the underside. The brackets are let into the front edge of the platform and attached to the underside by means of wood screws.

Four holes are provided, two on each side of the bracket. The topmost hole will have to be re-drilled, countersunk to take a 3/16-inch screw, which is sweated into place.

This screw must only be long enough to clear the panel and engage a wing nut on the opposite side.

We now have a right-angled assembly consisting of a vertical lens panel, attached to the hood by a hinge, and a horizontal camera support, adjustable for height on the vertical piece.

The degree of adjustment provided should be adequate for most cameras. There is even sufficient height to permti use of the viewing lens of a twin lens reflex for a fine vernier focus, transferring to the taking lens for the shot.

As mentioned previously the supplementary lens will need to be approximately 10 inches from the CRO screen surface, preferably with some provision for adjustment. We suggest mounting the lens in a tube, which can be made a tight, slide-fit in a hole in the vertical board.

EXTRA THICKNESS

To prevent any chance of the tube being misaligned, it is a good plan to add a second thickness of wood to the internal face of the vertical board and large enough to accept a 2-inch diameter hole.

The lens tube we used had an external diameter of two inches and an internal diameter of 1 13/16 inches or 44 mm. The lens was cut to a diameter smaller than that of the tube by about 2 mm. to allow for the difference in the coefficient of expansion of glass and metal.

A length of 1¾ inches for the tube should suffice to clear the double thickness of panel and to provide some degree of adjustment.

To retain the lens within this tube two more sections of tubing are required. The length of these should be such as to place the lens about ½in from the outside end of the tube. These lengths are used as retaining rings and are made to slide within the main tube by sawing through the wall and springing them to a smaller diameter. No additional fixing should be necessary.

It is essential that the supplementary lens be exactly at right angles to the line of sight, and the retaining rings must therefore be cut very accurately. Parting off in a lathe is obviously the best method.

A point to remember is that many oscilloscopes, or pieces of apparatus under test for that matter, react to surges in the power line, producing occasional movement of the trace on the screen. It is a good thing to be able to see the screen at the moment of exposure to be sure that such movement has not prejudiced the result. If flutter is observed at the wrong moment, it is usually not difficult to repeat the exposure on the spot.

VIEWING HOLE

Possible approaches are the provision of a small viewing hole in the vertical board or the fitting of a reflex finder salvaged from an old camera. Alternatively, if a twin lens reflex is to be used, two supplementary lenses could be fitted to the jig, to allow the camera to be used as normal. If the viewing position is a problem, the camera could be used on its side.

A word about photographing square or triangular waveforms. Due to the fast rise time of such waves the vertical component is considerably less bright than the horizontal component. Bringing up the brilliance of the vertical component will cause flaring of the horizontal component.

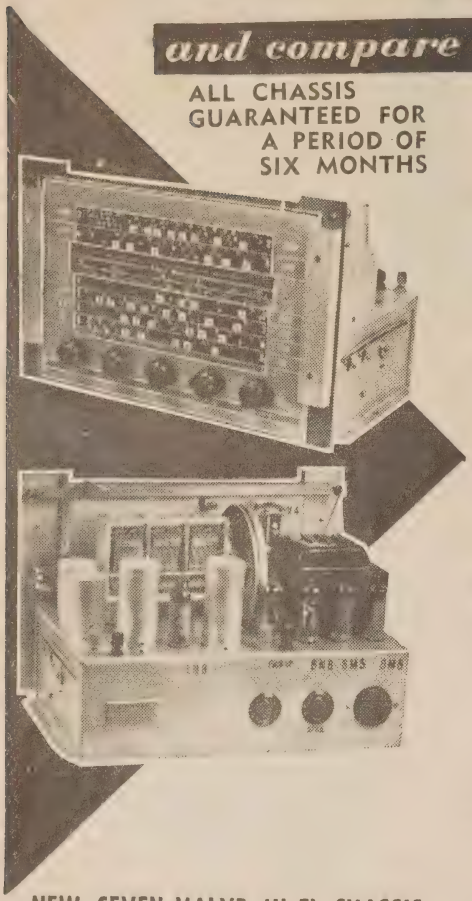
It is impossible to avoid the flare if it is desired to record both components, since both the flare and the vertical component have an equal degree of brightness.

before purchasing your radio see our—

Hi-Fidelity

RANGE

and compare these NEW features..



ALL CHASSIS GUARANTEED FOR A PERIOD OF SIX MONTHS

NEW:

Ultramodern circuit using nine high gain valves including "magic eye" tuning indicator. Permatuned iron cored coils and intermediates giving excellent interstate reception and a short wave range of 12,000 miles. All valves used are the new Mullard nine pin Innoval series.

NEW:

Ion control and audio stages incorporating the Mullard 5/10 amplifier circuit with separate bass and treble controls giving plus or minus 15 db boost or cut at 50 cycles L.F. and 10,000 H.F., combined with push-pull output with inverse feed-back gives you really high fidelity reproduction from your radio or favourite recordings.

NEW:

Dual Speaker combination, using a heavy duty wooter (12in M.S.P. Jensen AU54 special) with matching 6in tweeter and cross-over network giving a frequency response of 46 to 13,000 cycles. Speakers are mounted coaxially making only one 11in mounting hole necessary.

NEW:

If required the new Magnavox high-fidelity twin coned speaker can be supplied. Large calibrated edge-lit dial in plate glass (11in x 7in) with main stations of each State in prominent type. Dial fitted with counterweight drive, giving smooth tuning. Indicator lights are fitted showing which band is in operation. Dial can be supplied in cream, black or brown with matching knobs and escutcheon to suit contemporary blond or walnut finished cabinets.

NEW:

Sensitive "magic eye" tuning indicator (EM80) making tuning simple and positive even on interstate, overseas and country stations.
All chassis are wired for the fitting of F.M. tuner or tape recorder, special plug being provided on back of chassis, also pick-up terminals and outlet for gramo motor.
Power switch is fitted to volume control, radiogram switch, combined with wave change switch. Audio end of set can be used with TV receiver if required.

A NINE VALVE HIGH-FIDELITY RADIOGRAM CHASSIS

Nine and ten valve chassis incorporate the Mullard 5-10 AMPLIFIER CIRCUIT Frequency response 40-13,000 cycles Max output 10 watts.

£41/15/0

F.O.R.

A NEW 10 VALVE DUAL WAVE RADIOGRAM CHASSIS

WITH BASS AND TREBLE BOOST

The ideal chassis for those difficult locations where reception is doubtful. Specifications are nine valve unit, but with the addition of high gain tuned R.F. stage giving greater sensitivity and selectivity on both broadcast and short wave bands.

£44/15/0

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NEW SEVEN-VALVE HI-FI CHASSIS

This new compact dual wave seven valve chassis uses the same tuner circuit as our 9-valve unit with the Mullard tone-control circuit giving separate bass and treble controls. Push-bull output using two of the new 6BM8 dual purpose output valves and heavy duty M.S.P. speaker

£31/15/- F.O.R. PACKING 10/- EXTRA

Also available with Magnavox 12W.R. Hi-Fi speaker and Ferguson output transformer at £4/15/- extra.

Write for full specifications

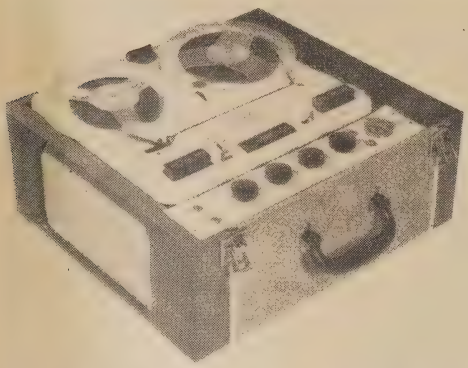
ALL 4 SPEED RECORD CHANGERS AND PLAYERS STOCKED

Classic Radio

245 PARRAMATTA ROAD, HABERFIELD, N.S.W. PHONE UA2145

Buying a Tape Recorder?

First see and hear the new Hi-Fi Recorder by Classic incorporating the new Collaro Mark IV Transcription deck. The only deck with ALL these features.



THE COMPLETE UNIT IS SUPPLIED IN ATTRACTIVE AND DURABLE TWO-TONE PLASTIC-COVERED CASE COMPLETE WITH ACOS MICROPHONE AND FITTED WITH DUAL ROLA SPEAKERS

The six-valve amplifier incorporates the latest "Mullard" tape recorder circuit equalised to C.C.R. standards giving perfect reproduction from recorded tapes. Record monitoring and outlet to power amplifier. Extension speaker outlet and "magic eye" level indicator. Amplifier is completely shielded and fitted with perspex dress plate to match deck.

- **HIGH FIDELITY**
  Heads are double coil wound and will reproduce up to 12,000 c.p.s. at 7½ inches per second. Azimuth adjustments on both impedance "record" and "playback" heads. Output of heads is approximately 5 milli-volts at 1 Kc at 7½ inches per second.
- **INSTANTLY REVERSIBLE**
  Instantaneous changes can be made from one track to the other. Fast rewind in either direction
- **CONSTANT TAPE TENSION**
  A special Collaro device ensures a constant tension on the tape on the take-up spool as it leaves the capstan.
- **FULLY MECHANICAL**
  No solenoids are used in the construction of this Transcriptor. The braking is entirely mechanical.
- **FINISH**
  Cream Polystrene cover plate with maroon controls.
- **THREE SPEEDS**
  3¾, 7½ and 15 inches per second.
- **FOUR HEADS**
  Two "Record/Play-back" and two "Erase" heads are sited on two different levels and head wear thus halves for any given length of track.
- **TWIN TRACK OPERATION**
  One pair of heads for each track. Both top and bottom tracks can be recorded or played back without removing tape.
- **PAUSE CONTROL**
  This has the effect of stopping the transit of the tape past the "Record/Play-back" and "Erase" heads and applying the brakes to the spools while leaving all switches and mechanical functions in their selected positions. Typical application is to pause whilst recording to omit speech interposed between musical selections. Control will only work whilst it is held in position.
- **TAPE MEASURING & CALIBRATING DEVICE**
  The three digit counter makes the location of any recorded passage the simplest of operations.
- **TRANSCRIPTION TECHNIQUE**
  A large diameter flywheel with ground and lapped steelshaft running on a ball at the bottom of long bearing reduces friction and virtually eliminates "wow" and flutter at less than 0.15 to 1.0 per cent.
- **TWO MOTORS**
  Each dynamically balanced motor does only one job at a time. Motors never act against each other and are of low wattage input with consequent reduction in heat and wear.

COMPLETE RECORDER WITH MIKE — 84 GNS. f.o.r.

DECK WITH AMPLIFIER, POWER SUPPLY and 6in x 9in SPEAKER, 71 GNS.

BUYING STEREO EQUIPMENT?

First see and hear our complete Range of **Stereophan** Hi-Fi Stereo Units — available early December

Complete Tuner and Amplifier for Stereo comprising a compact Hi-Fi 13 valve stereogram in two units featuring a dual wave tuner, multi-input two channel pre amplifier with tone controls in one unit and two 7 watt push-pull amplifiers with power supply is second unit. Two pair of M.S.P. or two Magnavox 12WR are supplied. **£66/17/6 F.O.R.**

Classic Radio

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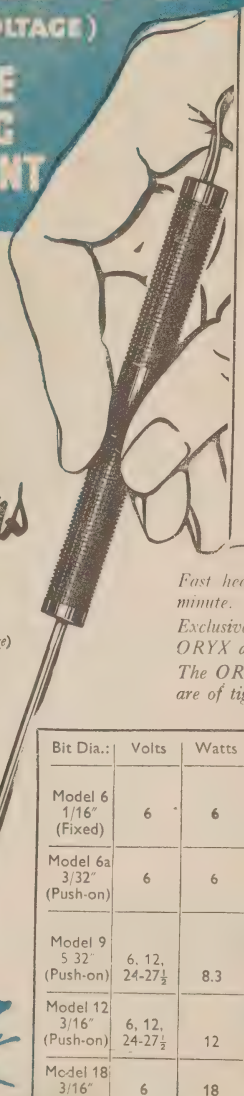
ORYX

(LOW VOLTAGE)

MINIATURE SOLDERING INSTRUMENT



A must for Transistors

(*actual size*)

PROTECT YOUR TRANSISTORS WITH ORYX

There is a danger of damage when soldering to transistor leads, due to A.C. leakage currents. The use of a low-voltage transformer supply, with earthed secondary is therefore recommended. Take care also that too much heat is not applied to flying leads. The ORYX iron, and a heat-sink such as heavy pliers gripping the lead between the contact point and the transistor, will ensure protection.

Fast heating element, ready for operation in less than one minute.

Exclusive design features resulting in universal acceptance of ORYX as the standard miniature soldering instrument.

The ORYX long life element will outlast several bits which are of tight push-on fit.

Bit Dia.:	Volts	Watts	Nett Weight	Length	Recommended Use
Model 6 1/16" (Fixed)	6	6	0.25 oz.	6"	Electrical measuring instrument fine assemblies, hairsprings, R.F. pick-up and speech coils, hearing aid sub-assemblies, etc.
Model 6a 3/32" (Push-on)	6	6	0.25 oz.	6"	As for Model 6 (for extremely delicate work only).
Model 9 5 32" (Push-on)	6, 12, 24-27½	8.3	0.25 oz.	6"	Hearing Aids, Radio and TV Sub-assemblies, Coils, Electronic Instruments, Model Construction, Electro-Medical, etc.
Model 12 3/16" (Push-on)	6, 12, 24-27½	12	0.5 oz.	6.25"	Radio, Television, and Telecommunications assemblies.
Model 18 3/16" (Push-on)	6	18	0.75 oz.	7¼"	For heavier work, heat capacity equivalent to that of most 80 watt soldering irons.

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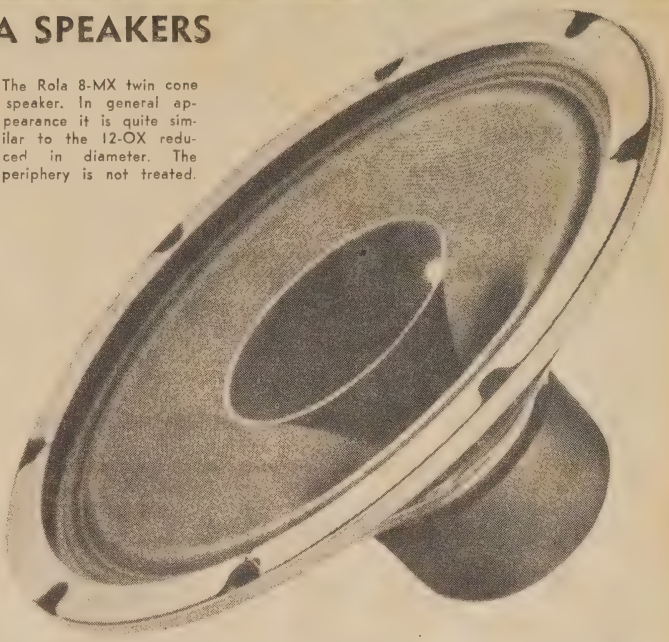
MSP3.58

TRADE REVIEWS AND RELEASES

THREE NEW ROLA SPEAKERS FOR TRANSISTORS HI-FI AND TV

Three new loud speakers have been designed and released by Rola, each intended to fill a requirement created by the latest developments in sound and radio. One is intended for high-quality, low-priced audio, particularly stereo, the second for TV receivers, and the third for transistor sets.



The Rola 8-MX twin cone speaker. In general appearance it is quite similar to the 12-OX reduced in diameter. The periphery is not treated.

THE 8MX is an eight-inch, dual-cone speaker in the tradition of the 12-OX and the 12-UX. It has a small tweeter cone cemented to the voice coil at the centre in a manner similar to that used for the speakers mentioned above, the intention being to increase the frequency response of the speaker.

This it does most effectively, as a run with an audio oscillator revealed.

The main cone resonnace of the unit tested was just over 60 cycles, a very useful feature in obtaining good bass response from the comparatively small baffles which would probably be used with it.

The upper response showed a rise in the region of 3-4 Kc, which is normal with this type of speaker, a dip at about 5.5 Kc and a rise at 9-10 Kc. Thus it should provide good presence on program, and as the high frequency response was sustained appreciably over 10 Kc, it has the ability to produce plenty of top.

It should make a very good unit for small stereo systems, as, adequately baffled, it will easily handle the output from a typical single-ended stage. Voice coil impedance is 15 ohms.

The TV speaker is intended to fit into a TV cabinet with the least use of frontal area, and therefore has the unusual oval shape of 10 x 3 inches. The frequency response therefore follows a more complicated pattern than normal, but it sounds very well and should be ideal beneath or at the side of the picture screen. It is a single-cone type, but because of its shape combines some of the advantages of both large and small cones.

Voice coil impedance is 3.5 ohms and cone resonance about 120 cycles.

The third speaker is the baby of the range, with a 2-inch cone and over-all diameter of 2 3-8 inches. Known as the 2-C, it has a 15-ohm voice coil intended for direct connection to a transistor output stage in portable receivers.

Its main cone resonance appears at 320 Kc and the response has a sharp rise at 3 Kc. For such a small speaker the sensitivity is quite good.

These three new speakers will undoubtedly be most useful additions to the Rola range.

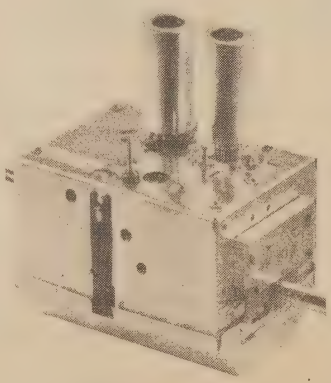
Retail prices are—8-MX, 90/-; 2-C, 38/6; 10-3G, 55/-.

CYLDON TV TUNER MADE IN ENGLAND

Manufactured in England, to suit Australian Standards, the Cyldon television turret tuner is now freely available to local set builders through Messrs J. H. Magrath & Co. Pty. Ltd.

THE Cyldon tuner uses an ECC84 twin triode as a cascode RF amplifier stage and an ECF80 triode-pentode as a frequency changer. Aerial input to the tuner is by a balanced 300-ohm line and output to the IF channel by a short length of coaxial cable.

The turret mechanism appears to be well engineered, with self-cleaning contacts and positive stop mechanism. The turret is ready loaded with coils for all 10 Australian Channels and the unit is tested and prealigned ready for immediate installation in the chassis.



The Cyldon tuner.

Access to the internal wiring is gained by slipping off a bottom cover, after which the turret rotor assembly can be withdrawn. If further access is required, one side plate can be removed by undoing two self-tapping screws.

The unit supplied for review has an anti-corrosion finish and also carried a tuning spindle no less than 7½ inches long, which would allow it to be placed, in special layout arrangements, well back from the control knob position. To use the unit in the standard R., T. and H. chassis, it would be necessary to reduce the shaft length considerably, or order one with shorter shafts.

For purposes of test, the tuner was mounted temporarily in the chassis of the 1958 R., T. and H. TV Receiver and connections made to existing supply points and to the IF input lugs. Stations were tuned immediately and a mere touch-up of a couple of cores was sufficient to produce a near-optimum response curve.

The tuner is priced at £12/14/9.

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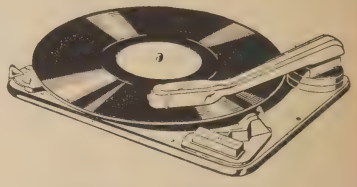

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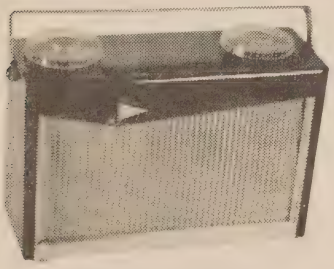

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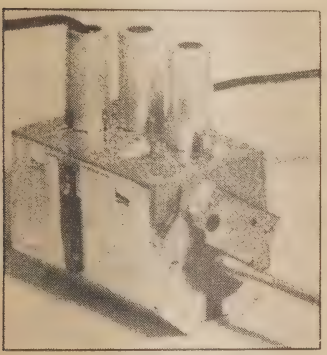
Q-PLUS RELEASES NEW TV TUNER

During the month, we had the opportunity of wiring into a receiver the Q-Plus type VTT/1 television tuner, manufactured in Australia by Messrs. R. W. Steane & Co. Pty. Ltd. It appears to function very well indeed.

THE tuner follows what are now well-established practices in turret design but the manufacturers have obviously paid a great deal of attention to accessibility and ease of service. In this respect, it is the best tuner we have yet handled. The outer cover springs off, without the need to undo holding screws, while the turret and coils slip straight out when two springs are released.

This reveals the sockets and wiring in a shallow dish, readily accessible for inspection or service.

Manufacturers' specifications indicate that the tuners are prealigned to a bandwidth of 14 Mc between the minus 6 db points, with a noise figure of less than



The Q Plus TV tuner.

6.5 db. Standard input is for a 300-ohm line with a voltage standing wave ratio approximating 1.25:1. Maximum gain from input to the input grid of the first IF amplifier is given as in excess of 40 db.

Image rejection with normal 300-ohm balanced input is quoted as minus 54 db, and IF rejection as greater than 60 db. Oscillator radiation is claimed to be substantially less than the minimum recommended by the Australian Broadcasting Control Board.

It would take more time than was available to double-check all these specifications but the general behaviour of the unit, when wired into a typical receiver, indicated that the performance was, indeed, of a high order, with interference patterns noticeably absent.

The tuner connects to the IF channel through a short length of 50-ohm cable and to the supply wiring by means of a tagstrip. There was no difficulty in obtaining an optimum response curve both through the IF injection test point and overall from the aerial input terminal.

Goodmans' 3-Speaker System

HIGH POWER AND SOUND QUALITY

Goodmans, well known for their rugged and reliable range of high-quality loud speakers, can now supply an elaborate 3-speaker system in a high-quality enclosure complete with cross-over network and individual gain control for the middle and higher ranges.

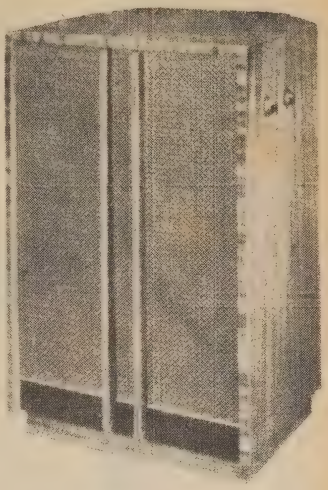
THE low frequency unit is the Audiom 60, which covers the range from 30-750 cycles. It is mounted in the lower portion of the cabinet which features the Acoustic Filter unit developed for Goodmans to give smoother sound from the vented enclosure design.

The range between 750 cycles and 5 Kc is covered by a pressure-type, horn-loaded speaker known as Midax, and the upper register to 16 Kc by a second pressure speaker, also horn-loaded, known as Trebax.

The cross-over network is a double divider type comprising four half-section filters. Each has a constant impedance attenuator calibrated in 2 db steps to facilitate balancing for local acoustics.

Midax and Trebax are mounted in the upper section of the cabinet which is thick-walled and very rigid. It is suitable either for corner or wall standing positions, and has plug and socket connectors for the speaker leads.

When fed with a suitable amplifier, the results from this system are extremely impressive. They were used in two stereo lecture-demonstrations by the editor of this magazine in different halls in Sydney, and had no difficulty in filling them with great volume and power.



The Goodmans 315 speaker system.

The horn loading provides great brilliance and good transient response, and driven with two 17-watt amplifiers, the units showed no distress at high output.

Cabinet height is 37in, width 23½in, and depth 21½in. This is one of the finest speaker combinations available on the Australian market.

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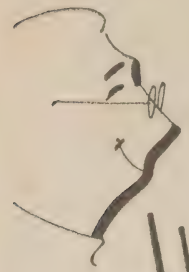

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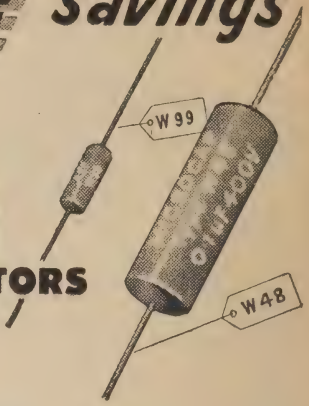

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NEW BOOKS

BRAINS TRUST

HIGH FIDELITY SOUND PRODUCTION by E. MOLLOY. Published by George Newnes, London. Price 33/3 plus 2/- postage. 200 pages, stiff cover.

This book is really a collection of ten chapters, each written on a different aspect of sound reproduction by ten different authors.

For instance, James Moir, himself the author of a splendid and exhaustive book on sound, writes on The Acoustics of Sound Reproduction, E. J. Jordan, of the Goodmans Company, deals with loudspeaker enclosures, Ralph West with Electrostatic Speakers, and Stanley Kelly with Record Reproduction.

All of these people are authorities and excellent writers. They deal with the fundamentals of their subjects concisely and with free illustration.

The chapter on Amplifiers, by George W. Tillett, has some useful reference circuits of commercial equipment, which are of great value to anyone who is making his own. It also carries a useful list of references.

Its field is very wide, commencing with a chapter on Subjective and Objective Judgment of Performance, and ending with one on Radio Reproduction, again illustrated by numerous circuits.

A well produced and most interesting book.

Our copy from the Technical Book Company, 295-297 Swanson Street, Melbourne.

FAMOUS NAME

AUDIO DESIGN HANDBOOK, by H. A. Hartley. Gernsback Library No. 71.

H. A. Hartley is a name well known in the audio world for the past 30 years, particularly in connection with loudspeakers.

As a designer he has pursued some unorthodox ideas with more or less success, the ups and downs of which are discussed in part throughout the pages of this book.

It is a practical treatise of 12 chapters and 224 pages commencing with the basic fundamentals of a hi-fi system, through the practical and theoretical points in design, Loud Speakers and Enclosures, Measurements and Testing, and some general notes largely reflecting the author's ideas.

Strangely enough, there is nothing at all about pick-ups in the book, nor for that matter about any input devices such as microphones or tape-heads.

Being essentially a reference and work manual, some useful data on resistance coupled amplifiers, characteristics of output tubes is included.

Inevitably much material overlaps that of similar handbooks, but it's well enough done and sufficiently different to stand on its own feet.

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Let's Buy An Argument

The letters in the September issue and my reply to same, about metering errors and battery portable power supplies have prompted further correspondence. This I like to see. It shows that, amongst the many who buy the magazine, a few still get around to reading "Let's Buy An Argument."

BETTER than ever, one of the contributors writes to commend the design of our power supply for portables, which another reader had queried. As we pointed out, the query was based on false premises — an attempt to measure output voltage with no load in circuit.

However, we shall let our correspondent speak for himself. I quote:
"Dear Sir,

"I was very interested in your discussion on metering errors in R. TV and H. for October. I have got used to reading about 5 volts on the 250 volt range on the screen of a 1S5 (load resistor 3 megohms) and working out in my head that if the resistor had gone high or the by-pass become very leaky, the volts will be more like 2 on the same scale.

REALLY WORKS

"Regarding the letter from G.P., I can assure him, and any other mystified meter reader, that the supply unit really works. I have built a number of them, and although in some cases it is necessary to increase or decrease the dropping resistors by 10 or 15 per cent to get 8 and 90 volts, the circuit is a sure-fire and very reliable design. It is much simpler than most of the commercial designs, and seldom gives trouble.

"So far from there being any danger of burning out the filaments with this unit, I have found it almost foolproof.

"Recently I re-wired the filaments of a battery set from parallel to series, but missed the earthing wire on pin 5 of the IF 1T4. The set wouldn't work, as there was no voltage on the 1S5 filament. But the voltage across the other filaments did not rise by the 1.3 volts that should have been across the 1S5.

"Instead the filament volts fell to 6.8 due to the increased current through the 3,000 ohm resistor, or partly so, and partly due to the reduced resistance of the filament string.

by Neville Williams

If anyone wants to try the unit without a receiver, he should use a 180 ohm 1 watt or higher resistor across the 8 volts output and a 6,000 ohm 3 watt resistor in the 90 volt circuit to get the same conditions for measurement as would occur in the receiver.

"The last couple of years the nominal 225/50 transformers appear to be conservatively rated, so that, with a 3.4 henry choke having a DC resistance of 550 ohms, it is still necessary to increase the HT dropping resistor to 3,000-ohm 3-watt to keep the volts below 100. If both LT and HT voltages are too high, a 3-watt wirewound resistor of 150 ohms or so between rectifier cathode and choke often does the trick.

BETTER VALVE?

"Where one is not cramped for space, the 6V4 is a more reliable valve than the 6X4 for this unit. The 6X4 loses emission rather more quickly. — R. K. Mungungo, Q'ld."

Many thanks, R. K. for your letter.

May I add a remark to your observations about what happened when the 1S5 filament was inadvertently shorted out. One or two readers have wondered whether the filament circuit is unduly critical.

The 3,000-ohm resistor and the filament network, the latter representing about 180 ohms, are connected in series across the filtered H.T. supply. The figures are such that about 50 milliamps of actual filament current flow through the circuit.

If one filament, representing 28 ohms, is shorted out, the total series resistance changes from a nominal 3.180 to 3.152 ohms—a variation of less than 1 per cent!

LITTLE DIFFERENCE

Conversely, adding an extra filament to the string, representing an extra 28 ohms, would make a similar trifling difference to the resistance and therefore to the current flowing.

In other words, the difference in current occasioned by adding or subtracting one complete filament would be a lot smaller than what could result from the normal tolerance in the circuit components.

Another letter, on this same general subject, comes from a reader in Mt. Lawley, W.A. I suggest you read it in the panel on the facing page.

The fact that he is confused is not altogether surprising, since his thinking is astray on three major points raised

PUZZLED BY A FILAMENT CIRCUIT

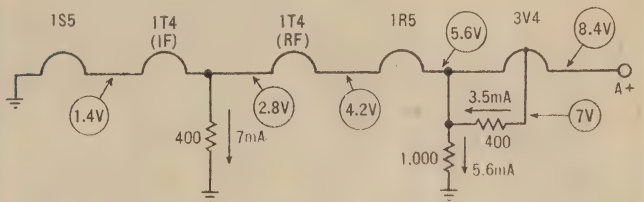
Dear Sir,

I have a problem which has troubled me on and off for the last five years, that of running battery valve filament in series. The system in question is that used in the "Rambler Portable" (Oct., 53.) and subsequent Battery AC Portables.

The diagram herewith shows the essential part of the circuit, omitting bypass capacitors, whose operation I understand. If we assume a supply of 8.4 volts, the voltages to earth read at each valve socket should be, (and as far as I remember, are approx.) as shown. If these are correct, the currents flowing in each of the three resistors will be as shown.

If these currents are "HT returns," I can see where the 7mA in the first 400-ohm resistor come from since this is approx. equal to the sum of the total screen and plate currents of the two 1T4's. Also the current through the 1000-ohm pretty well accounts for the plate and screen current for the 1R5. However, what of the 12.5 mA for the 3V4?

Again, if no HT is supplied to the set, it appears that 62.5 mA will be flowing through the first half of the 3V4 filament. Aren't these filaments supposed to be particularly fragile?



Another point is that the convertor grid is returned via the AVC line to a point 9 volts positive with respect to earth and 4.2 volts positive with respect to its F-pin. Why is this, if the valve data books quote a figure of zero bias? If you could clear up some of these points I would be very grateful.

Yours faithfully, L.P.

in his letter. That doesn't sound like a very good average but then most of us get mixed up on occasions.

First and foremost, we had better explain why supplementary resistors are necessary at all in a series filament network. This, by the way, is not for our correspondent's benefit. He obviously knows the answer to this one.

If only the filament current had to be considered, the filaments could simply be connected in series and the same current would flow through each one of them. This normally would be 50 milliamps and, allowing for slight and inevitable variations in filament resistance, would result in a voltage drop of about 1.4 across each filament section.

EXTRA CURRENT

But, in a practical receiver, the problem doesn't end there. The plate and screen current from the second valve in the network (here a 1T4 IF amplifier) has to flow to earth and the most obvious path is through the filament of the first valve (the 1S5).

It so happens that it adds to the filament current already flowing, so that the total current flow through the 1S5 could rise to over 54 milliamps—an increase of 8 per cent.

So the process multiplies, each filament having to pass the normal 50 milliamps plus a proportion of the plate and screen currents of the valves further along the network. And since the total H.T. current of a battery set (say 12 to 15 milliamps) is from 24 to 30 per cent of the series filament current, it is obvious that the distribution of filament currents and potentials must be seriously disturbed by it.

To offset the effect, receivers such as the "Rambler," employing series filament strings, have a number of resistors included, shunting individual filaments or groups of filaments.

The value of these additional resistors is arranged so that they pass about the same order of current as would otherwise flow through the relevant filaments, due to the H.T. current of other stages. They therefore serve to maintain the actual current through each filament at something like 50 milliamps.

EACH FILAMENT

To be precise, there should be a resistor across each individual filament section, except perhaps the section nearest the 9-volt terminal. However, to save components, only three resistors are used in the "Rambler," the resulting compensation being reckoned as near enough.

One of the resistors is used to balance the current through the 3V4's own filament, and is recommended by the manufacturers. The fact is, of course, that the 3V4 output valve draws substantial plate and screen current, and a balancing resistor is desirable, as well as another resistor to shunt this amount of current to earth.

The HT current drawn by other individual valves is much lower and a single resistor from the centre of the filament group is adequate.

Now to get to the points raised by our correspondent. It is an over-simplification to assume that the 7 odd milliamps flowing through the 400-ohm resistor pertains to the two 1T4 valves. Actually a large proportion of the 1T4 IF current will reach earth via the 1S5 filament, though not enough to present any hazard.

It would be nearer the truth to suggest that most of the current flowing through this resistor could be credited to the 1T4 RF amplifier and the 1R5 converter. The other two resistors have largely to do with the current drawn by the output valve.

The second point has to do with the order of the currents drawn. If these were merely read out of the book they would add up as follows:

1S5	2.0mA.
1T4	4.9mA.
1T4	4.9mA.
1R5	5.0mA.
3V4	9.2mA.
Total	26.0mA.

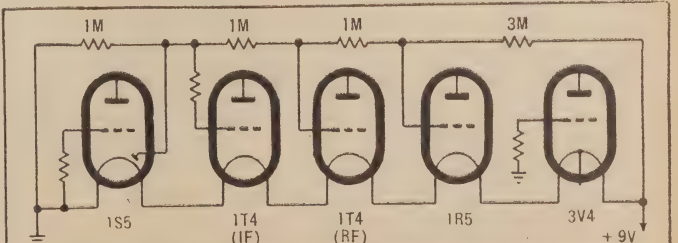
A total current of this order could not be countenanced with a battery set and something like half the figure has to be achieved to give reasonable economy of battery drain.

Working through the figures again, the 1S5 can almost be ignored because the actual drain, with large value resistors in plate and screen circuits, is very small indeed — something under 50 microamps. In fact we shall forget it.

Maximum drain for the 1T4's can be limited by reducing the screen voltage, with some loss of gain. It might typically be reduced to about 3 milliamps per valve, remembering that the drain may fall, in practice, to a mere fraction of this, with input signal and AVC voltage on the grids.

Some economy may likewise be effected in the 1R5 stage by limiting screen voltage as far as possible, consistent with gain and reliability of oscillation.

Plate current for the 3V4 is lower for the series connection than the paral-



This is the bias and AVC circuit of the "Rambler" and similar portables, reduced to its basic form. Note how the detector diode and the AVC controlled grids tap along a resistor network which reproduces the potentials existing along the series filament string.

This entirely new unit incorporates every essential requirement for High-Fidelity, STEREO reproduction from Tape, records and Radio. Provision is also made for monaural operation, including Microphone and Tape Record. Versatile, the unit may be used with two JUNIOR or two CADET Amplifiers, while owners of a JUNIOR Amplifier may, if they wish, use a CADET as the second amplifier. Compact, the unit is directly interchangeable with the RD JUNIOR Mk. II Control Unit and styled to match other RD JUNIOR Units.

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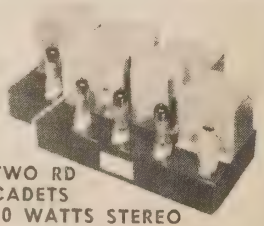

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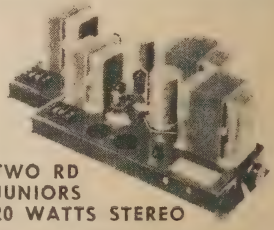

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lel connection and the 12.5 milliamps quoted by our correspondent is in error in any case. No-signal plate and screen current for the series connection add up to 9.2 milliamps for a bias of minus 4.5 volts.

QUITE SMALL

But here again, the bias relative to the negative filament pin is about minus 5.6 volts, so that the 3V4 drain is even less than 9.2 milliamps. In fact, on battery supply, with less than 90 volts between plate/screen and the already positive filament, and with higher then normal bias, the drain of the 3V4 might be quite close to the 5.6 milliamps which nominally flows through the 1000 ohm resistor.

At best, it might be regarded as not quite enough compensation but then, a slight margin of current through the converter valve filament might be considered a good thing. Quite frankly, I forget the exact thoughts that led us to specify the values we did.

Apparently they work out in practice, which is the important thing.

L.P. wonders what happens when no H.T. is applied. Naturally this would upset things, but then sets are not normally operated in this fashion.

The third point has to do with the distribution of bias to the various grids and this is one which has apparently puzzled quite a few readers.

Actually, the pattern of the bias network is not apparent from the main circuit diagram but the subsidiary diagram shown here should make it clear.

Neglecting the compensating resistors, which have already been explained, the valve filaments form a simple series network, with a nominal 1.5 volts across each of six filament sections.

At the same time, the grids return to a network of resistors totalling 6 megohms across the same 9-volt supply potential. Neglecting other influences, there must therefore be a nominal 1.5 volts across each 1-megohm of resistance.

GRID-LEAK BIAS

Now look at each stage in turn: The IS5 triode grid returns to the same earth potential as one end of its filament, through a 10-megohm resistor. It therefore operates with normal grid-leak bias.

The diode plate is opposite a filament strand 1.5 volts positive with respect to earth but, since the diode returns to a 1.5-volt positive point on the resistor chain, it operates as normal with no delay bias.

The grid of the IT4 IF amplifier returns to this same 1.5-volt positive point but, since the negative filament pin of this valve is also at 1.4 volts positive, the valve operates with zero effective initial bias.

The same reasoning applies to the IT4 RF amplifier, in which the grid and the negative filament pin are both above earth by 3 volts. The effective bias therefore remains at zero volts.

By the same process, the IR5 is plainly operating with zero initial bias, not a positive bias, as our correspondent suggests.

When the IS5 diode conducts in the presence of signal, it produces a reverse current through the 1-megohm diode load to earth, making the free end less positive or actually negative.

This negative swing is applied directly to the IT4 IF grid as an AVC bias. Because of the divider action of the resistors, four-fifths of the negative excursion reaches the grid of the IT4 RF amplifier while three-fifths reaches the grid of the IR5. The AVC action is therefore fairly complete and certainly adequate for a portable battery set.

The bias on the output valve remains fixed at a figure equal to the drop across the first four filaments. This is so because the output valve grid returns to earth.

Finally, what was the reason for specifying the valve filaments in this particular order?

Well, the IS5 more or less has to be at the earthy end of the string to make possible the foregoing control action.

Then, since no delay is available in the AVC, the RF grid was allowed to receive slightly less control than the IF grid, rather than the other way round. This ensures that, while ample control is still available on strong signals, the RF stage is operating to better advantage on very weak ones.

The 1R5, in the position shown, receives enough control to be useful, but not so much as to be a stability hazard in the event of the circuit being used for dual-wave reception.

And that, I think, should be enough on this one subject.

ABOUT SIGNAL-TO-NOISE RATIO

Dear Sir,

Could you please enlighten me on a point concerning signal-to-noise ratio in receiving sets. This problem has had me puzzled for some time and is as follows:—

It has been my experience that many sets with no RF stage have a far better signal-to-noise ratio (on local stations) than those that have an RF stage incorporated. This has only been noticeable however when neither set has an aerial connected. With only a small aerial in use the RF sets immediately came good and outshone the other type easily.

This has been noticed on several sets and so is not due to a faulty RF set and superlative non-RF radio.

In other words the high noise level in the RF sets cannot be attributed to the RF valve being faulty, the operating conditions being wrongly chosen, the circuit being faulty elsewhere or the location itself being unsuitable. These are the only factors I can think of as producing the extra noise and so I am now beaten completely and absolutely.

The inclusion of an extra stage in a radio set, the RF stage, would of course introduce some extra noise due to the electron movement in the extra valve but I have been led to believe from various books I have read that the extra gain produced by the RF stage would outweigh this factor and even improve the signal-to-noise ratio on the whole by presenting a larger input signal to the grid of the frequency converter, a notably noisy valve in comparison with the others.

So having stated all the relevant facts I can think of I leave the solution to you hoping, justifiably I'm sure, that you will be able to relieve my mind of one more problem.

Yours sincerely,
G. M. (Meltham, W.A.)

P.S. Flattery will probably get me nowhere but in my humble opinion your magazine is a truly magnificent institution even if insufficient attention (in my opinion again) is paid to High Fidelity (Say 150% of the magazine?). You can count on me as a full time subscriber any day.

SIGNAL/NOISE RATIO

From a reader in Western Australia comes a letter about the signal-to-noise ratio in receivers. At first reading I was inclined to say "phooey" because:

(1) I had not personally noted the effect;

(2) It seemed most unlikely as a general rule, despite his statement that it was; and

(3) It has little practical significance in relation to the way in which a receiver is normally used.

However, on thinking the matter over, I am inclined to agree that there is good reason why receivers may—as a general rule—behave in the way G.M. suggests.

Having said as much and, if you want a bit of technical exercise, why not read the letter and work out for yourself a possible explanation?

Do it now, before you go any further.

RANDOM EFFECT

First and foremost, the ability of a receiver to tune in signals without an aerial is a purely random effect. It depends on the strength of the said signals in the vicinity, the penetration of the signals into the receiver by way of mains wiring, the effectiveness of the receiver earth connection (if any), the amount of exposed signal frequency wiring attached to grids and plates, and of course, the sensitivity of the receiver.

In saying this we are talking about a random characteristic of ordinary receivers, as built on a metal dish chassis, with open wiring.

The pertinent question seems to be this: If no aerial is connected to the receivers in question, how is the signal reaching the frequency changer and thence the IF amplifier?

Is there any guarantee that it is passing through the RF stage at all, where such is included?

In the practical design of a receiver including an RF stage, it is likely that the aerial input lead within the chassis and the RF grid lead will be short and isolated by shields or earthy components, because such precautions would be necessary to ensure RF stability.

It is logical to think, therefore, that the input wiring of an RF stage would be strictly limited in its ability to pick

(Continued on Page 123)

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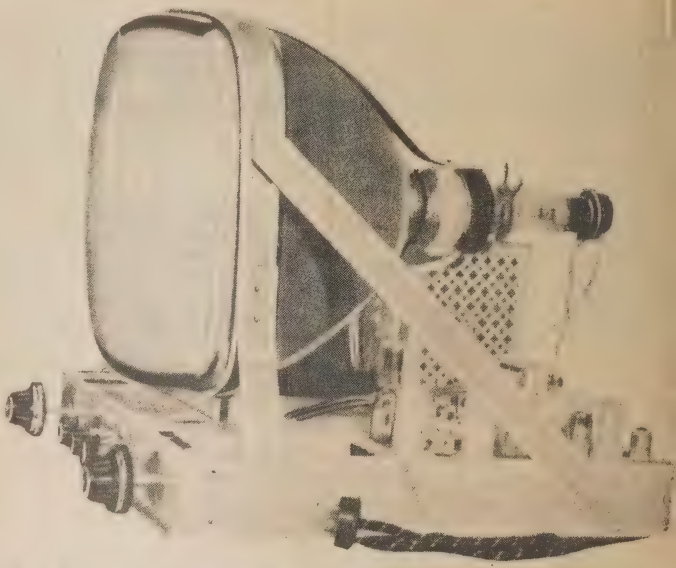

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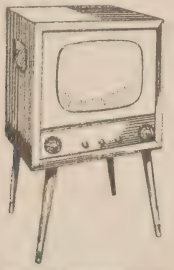

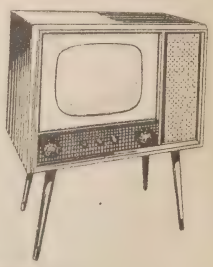

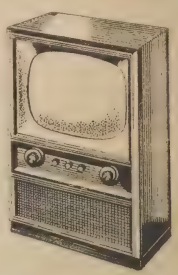

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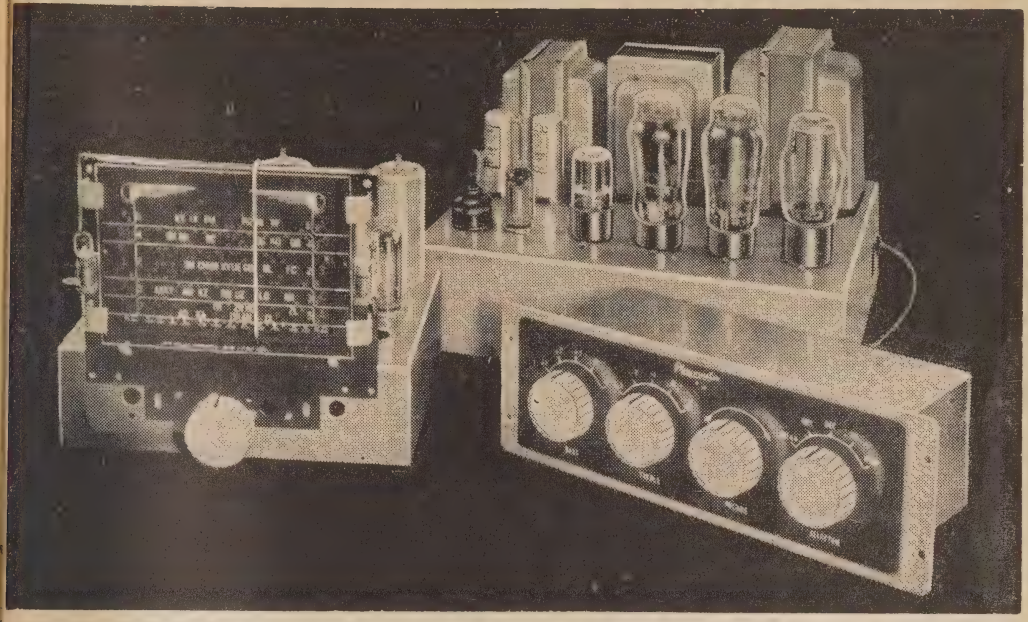

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STEREO AMPLIFIER

Interest is growing rapidly in stereophonic sound and we are happy to announce that kits or completely built units are now available for the STEREOPHONIC AMPLIFIER designed by John Moyle ("Radio, Television and Hobbies," July, 1958). STEREOCRYSTAL CONTROL UNIT ("Radio Television and Hobbies," October, 1958), and STEREO PICK-UPS and CARTRIDGES ALSO AVAILABLE. Send coupon for price and all details on items required.

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OFF THE RECORD — NEWS & REVIEWS

What is the "true" stereo effect? Is there such a thing, or can we expect to define accurately something which is essentially an illusion? Is it rational to commence from a recording method we think should be ideal, and rejecting any other manufactured methods which might sound better?

by John Moyle

I HAVE been thinking a good deal lately along these lines. There isn't any doubt about the extra interest and effect of stereo, and we can say in general that we want something that makes music sound bigger and wider and deeper and apparently more like an original.

Isn't the best disc one which most nearly achieves these things in one's own listening room, irrespective of how it was made?

I was intrigued to receive a letter from Hermann Scherchen a few months ago, who, apart from being one of Europe's leading conductors, is keenly interested in recording, and maintains a fully equipped recording centre at his home in Gravesano, Switzerland. When I visited him in 1956 it was just taking final shape.

He told me that he had developed a stereo system of his own far better than those existing at present, and using standard single channel recording material.

I began searching for some information on ways and means of doing this when I came upon a most interesting article by Oliver P. Ferrell in HiFi and Music Review, published in the U.S.A.

It said so much that was of interest about the subject that I thought I would reprint it in place of remarks of my own, most of which would be, if not so well informed, at least of similar content. Here it is.

FUTURE OF THE PAST

"The advent of the stereophonic disc raises this predominant question—'What happens now to the artistic heritage of the phonograph? Will the musical treasures of the monaural age die of technical obsolescence?

"In this sense, stereo is a far greater upheaval than the change from standard discs to microgroove a decade ago. For any worthwhile material existing in the the older type of records could be transferred to a new medium. But the barrier between the monaural past and the stereo future is far more formidable.

"Those who value musical merit above mere sound have great misgivings about substituting new stereo recordings for the old monaural treasures. They wonder if anything can be done about it.

"Several designers are already exploring the possibilities of fixing up old monaural recordings with a semblance of stereo. The principle by which this is done is called 'sound enhancement.' You take the recorded sound 'as is,' and by various forms of electronic trickery add to it certain acoustic factors that were not originally there.

"There is nothing new in sound enhancement. It has been used in the past to give wider dynamic range. Another form is the addition of full-throated reverberation to dry-sounding records originally made in acoustically 'tight' surroundings. The addition of a barrel-like echo has been standard practice for pop records to give the singer's voice whatever qualities of sultriness, hollow mystery, or smouldering passion please our teenagers.

"But never before has it been necessary to refurbish a recording with an entirely new dimension of stereophony. The difficulties of doing this effectively are tremendous. Yet the problem has been faced squarely, and its theory explored in a spirit of intensive and dedicated research. We are now at the point where the theoretical knowledge of stereo sound is sufficient to permit the design of commercial equipment.

PSEUDO-STEREO

Before we can manufacture the illusion of stereo by various enhancements we must be reasonably clear just what this requires. A pseudo-stereo effect would depend chiefly on three factors—

1. The time differential involved in the arrival of the same sound at two different points, corresponding to our own two ears.

2. The different sound reflection patterns at these two points, resulting in different phase configurations of the instantaneous sound spectrum. In other words the ups and downs of the sound wave at various frequencies differ at the two stereo reference points.

3. A variable method of controlling amplitude particularly with regard to attack on musical instruments.

—TV TIMES

Electronic engineers have tried to take a monaural sound source and subtlely superimpose difference in time, phase, and amplitude. The original sound is then played through the full range monaural channel and the modified sound through a second channel involving additional equipment and a speaker spaced eight to 20 feet away from the full range system. In theory this should result in an illusion of stereo where no stereo existed. This is analogous to stereo photography, where a depth effect is created by displacement of elements on a single plane combined with binocular perception.

The time delay factor in a reverberation or pseudo-stereo unit should be greater than 1/25th of a second. The phase shift is an intangible quantity since it depends almost entirely upon the nature of the program material. Theorists believe that rotations in excess of 1,000 degrees are necessary before a substantially effective pseudo-stereo acoustic illustration can be obtained. By and large, all of the units currently available on the market today ignore the question of amplitude "correction."

The first pseudo-stereo device offered to the general public is really a miniaturised reverberation chamber. Manufactured by radio craftsmen and labelled the "Xophonic," it operates by playing the music through a small speaker into a coiled pipe, picking up the sound through a second miniature speaker acting as a microphone at the other end of the pipe, amplifying the sound and feeding it to a built-in "second" speaker.

The sound, having travelled through the pipe, is delayed by about 1/20 of a second. This primitive method, although crude and subject to feedback problems, produces an interesting pseudo-stereo effect, which is neither mediumly decent stereo nor enhanced monaural programming.

LIMITATIONS

The frequency response is severely limited and the coiled pipe tends to add spurious resonances throughout the audible spectrum.

The secondary disadvantage of the system which involves having two loudspeakers and one microphone housed in the same cabinet makes the "Xophonic" unable to operate at moderately loud volume levels. The interesting pseudo effect could thus only be observed by the fellow who plays his music softly.

"Other devices rely on electronic methods of phase shifting to achieve pseudo-stereo. In these units, time delay can only be measured in milli-seconds and as a result the shoe is on the other foot.

"Most engineers agree that phase shift

lone without auxiliary appreciable time elay is just as impotent as time delay vithout phase adjustment. Designers of he Holt, the Royce 'Stereo-Rama' and inally the Ultron provide phase shifts in xcess of 400 degrees. Theoretically, ven this shift should produce some re-ognisable acoustic effect, and indeed, nder idealised listening conditions this is o.

"The Holt is the most proficient in this :ategory provided the recommendations is to speaker and speaker placement are ollowed to the letter. Less effective is he Royce and only a negligible illusion :ould be observed with the Ultron. Oddly enough, all three of the latter units will work if binaural headphones are used in place of separate speakers. Quite possibly, this is an aspect which should be investigated to a far greater extent since he audiophile rarely if ever has control over the vagaries of his room acoustics.

"It would be unduly harsh to state flatly that all of the above methods are false starts. The production of 'artifical' stereo is a vastly complex problem that is being closely scrutinised in several laboratories throughout the world.

SOME SOLUTIONS

"Two hopeful solutions to the pseudo-stereo illusion are now being tested. One of these was proposed by the redoubtable Paul Weathers whose FM monaural pickup has been well received. He has patented a device combining all three of the enhancing principles mentioned above. Unfortunately, although laboratory tests are most impressive, Weathers has no intention of putting it into production until the stereo disc dust has settled down.

"The Weathers device is highly effective with all types of program material and can even render an illusion of apparent motion. Three speakers are required —a normal full range system in the centre, plus a pair of smaller matched speakers on either side. Only the side speakers, working in opposite phase, are actuated by the Weathers system.

"Another encouraging report found famous conductor Hermann Scherchen busy working on the pseudo-stereo problem. In his remarkable sound laboratory high in the Swiss Alps, Dr Scherchen and his staff built a device called the "Stereophoner." Played from an ordinary monaural sound source, it provides a highly effective illusion of stereophonic depth and directionality.

"Before posing himself the task of constructing the actual 'hardware' of the Stereophoner, Dr Scherchen carefully isolated and defined the elements that make up the stereo effect. According to Scherchen, the following factors are involved.

REQUIREMENTS

"1. Directionality: You must be able to tell right from left. A sense of the orchestra's seating order must be preserved.

"2. Depth: The strings must have 'presence' — be out front. Winds, percussion and brass must appear behind them, and stay there.

"3. Spread: The orchestra must spread evenly across the stage. There must be no 'hole in the middle.'

"4. Avoidance of 'masking effects.' Low tones must not intermodulate with highs and thereby falsify tone colour. Instead of piling up all frequencies at a single point of origin, the frequency spectrum should spread out.

"5. The acoustic atmosphere of the place where the recording was made should not be falsified in the process of 'adding stereo.'

"The Stereophoner has been satisfactorily tested under laboratory conditions. Requiring only two speakers, it is simple and manages to hit quite a few points of Dr Scherchen's complex target. Little information is available on the actual operating principle of this device.

"Both the Weathers and the Scherchen devices bear proof that ways may be found to salvage our heritage of priceless monaural recordings for the technical demands of the future. Yet hope and expectancy must be tempered with this caution: — NO ENHANCING DEVICE, HOWEVER EXCELLENT, IS A SUBSTITUTE FOR GENUINE MULTI-CHANNEL STEREOPHONIC REPRODUCTION.

"The main value of a workable enhancing device is that it permits monaural record collectors to hear artistically irreplaceable monaural discs, of which they may have become very fond, in the sonic dimension of the future."

LONG WAY TO GO

On the face of it, Mr Ferrell's final remark seems to make sense, but we still have a long way to go.

If we are not bound by a monaural original, the position of "faked" stereo may be very different. We might even argue whether we can consider all stereo as being faked.

I have a feeling that the best stereo records are not necessarily to be those made with just two microphones set at right angles, or at the sides of an artificial head.

As of now, the test has yet to come.

* * *

TCHAIKOWSKY — Nutcracker Suite Opus 71A; BERLIOZ—Carnival Romaine Opus 9; WAGNER—Prelude to the Meistersinger. Played by the Symphony of the Air (N.B.C. Orchestra). World Record TT9.

As anticipated, this record contains some good playing, but to me it doesn't sound as successful as some of the previous releases by Toscanini's old orchestra.

More than once the lack of a conductor spoils its attack, as eventually must happen in the split second when players are waiting for the others to begin.

Nor has the sound the kind of impact we look for today, by comparison it is rather dull.

Maybe we must take these things as part of the price for a recording which has other virtues, and of course it has.

It's just that on this occasion I thought the balance sheet was pretty evenly divided.

The surface is only fair.

MUSIC FOR SUMMERTIME—Summertime, Star Dust, Smoke Gets In Your Eyes, Pavane, Stormy Weather, Shadow Waltz, Beyond the Blue Horizon, Cresta Blanca Waltz, Where or When, Orchids in the Moonlight, Over the Rainbow, and Time on My Hands. Played by Morton Gould and his Orchestra. RCA L16148.

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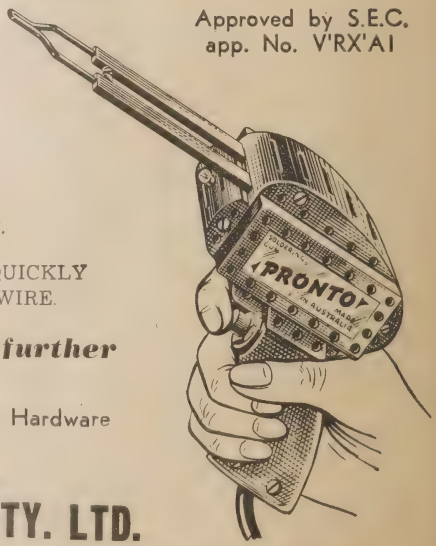

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s always been high, and today it is obably higher than ever. Most of them serve nothing better — mostly they inane variations on a monotonous d elementary formula, based on conntions and cliches, and at best with a nmick that soon loses its punch.

But there have been some which last many years, frequently mutilated out recognition by the latest fashions in rangements or orchestration, but rening their old appeal for all that.

And the reasons why they don't die e the same reasons that keep any other usic alive — simplicity, sincerity and on, qualities we can think about and ite down as the essentials for success.

But there is more than that — an usive something which isn't there at l until the music is played — an nergent quality which can't really be fined because it is different every time.

The appearance of so many such numrs on this record would almost guartee its success, but Morton Gould has ut this beyond doubt by his imaginative rangements and individual performnce. It's mostly nostalgic which isn't ut of keeping with Summertime, nor nwelcome where music for relaxation concerned, and there is ample variaon to keep you interested.

It sounded best to me with plenty of xtra bass — another of those discs hich is noticeably light at the low end. his recording technique contrasts so rongly with that of a year or two ago, nd appears so regularly, as to constitute trend.

Yet another good disc for the Xmas ocking.

★ ★ ★

THE LURE OF FRANCE—Madamoiselle de Paris, Under Paris Skies, Bonjour Paris, My Prayer, Mimi, La Mer, Autumn Leaves, April in Paris, Cla[illegible] de Lune, Pizzicato Polka, Depuis le Jour (Louise), Reverie, Girl With the Flaxen Hair, Can Can (Offenbach). Played by Andre Kostelanetz and orchestra. Coronet KLL 574.

A similar type of record to the "Viense Picture Book" and just as well proced in the manner upon which Kosanetz has ridden to popularity.

But the subject matter this time deals ith France. It is more ambitious than s Viennese companion, one side conaining well-known popular tunes, and ne other arrangements of more classial pieces.

If you are enthusiastic about the disrming Kostelanetz, you won't be disnayed by the long procession of numers. Nor by the practised exploitation f Debussy and the others, although the omance has been laid on with a capital .

Once again, it is a record which lives p to its label, if not to its cover.

Technically, the surface is a bit noisy, ut not sufficiently so to be a major azard. Discs such as these two make xcellent Xmas presents, for practically verybody likes them.

★ ★ ★

HANDEL—Royal Fireworks Music. Played by the Hague Philharmonic Orchestra, conducted by Willem van Otterloo. Fontana 495 000 TE.

Quite a good standard performance omplete on a 7-inch disc, but lacking in the full body of sound found in some other versions.

The final section, for instance, has an atmosphere of grandeur we generally like to hear, but which isn't completely achieved.

The jacket has an interesting and factual description of the music and of the circumstances in which it was first performed. Handel, who spent much of his life in England and is buried in Westminster Abbey, was an extremely popular composer of his time, and big crowds flocked to hear the first performance.

This music, together with the Water Music, which was written to patch up a misunderstanding he had with George II, are probably the two works most often played today if we except the Messiah.

On the whole, a competent disc.

★ ★ ★

MOZART.—Concerto for Flute, Harp and Orchestra in C, K299; Adagio and Rondo for Harmonica, Flute, Oboe, Viola and Cello, K617; Andante for Flute and Orchestra in C, K315. Played by soloists and the Pro Musica Chamber Orchestra of Vienna. Vox APL-8550.

Firstly, it should be said that the harmonica mentioned here is not a mouth organ.

It is an instrument with a keyboard and a set of glasses tuned to a scale, and struck so that a tune can be played on them.

For a time, the glass harmonica was quite popular in the late eighteenth century, and is reputed to be an American invention. It was one of the first non-classical instruments which gradually found their way into the orchestra as time went on, although it is never used today in normal performances.

Mozart wrote a good deal of music for various instrumental combinations, some to satisfy the requirements of patrons and some because obviously he wanted to, and because, as the jacket notes point out, he was "first and always a music maker." Most of such pieces are musicianly and delightful to hear: some are masterpieces.

The fact that many of them are highly stylised hasn't much to do with it——Mozart's formula was one which rarely failed and his ingenuity and invention were equal to all occasions.

I commend this disc most highly. It is beautifully performed.

The flautist and the harpist are the two most important instrumentalists, and one would not wish for more distinguished work. It is strange to learn that Mozart was not over keen on either instrument when we hear how well he handled them in various forms.

The recording has preserved and enhanced the delicacy of the music, mainly because of its excellent balance. In this regard I find it hard to be critical at all, or to suggest any better way of handling it.

The surface is first rate and the cutting seems flawless.

As far as musical achievement goes, it is one of the month's highlights.

★ ★ ★

CHOPIN—Four Ballades. Played by Jeanette Doyen. WG-W-18013.

There are some very fine Chopin players recording at the present time. It may not be so strange that the most famous executants are not always among these players. Some of the very best did not play Chopin at all, others, I feel, have made recordings more to round out their repertoire than to contribute very greatly to the state of the art.

On the other hand there are few composers who can stand so many lines of approach.

Jeanette Doyen is neither very good nor very bad—her record has its ups and downs.

I like it best for its quieter moments —the F major and F minor Ballades include some of them.

But it is easy to lose touch with sections of the ballades, or rather to fail in sustaining a coherent line through the music. As a musical form they are rather loose in character, and this doesn't help a pianist to keep to the point.

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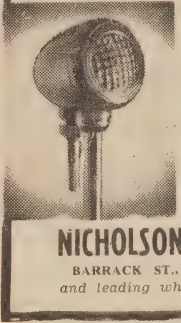

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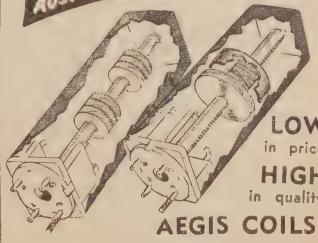

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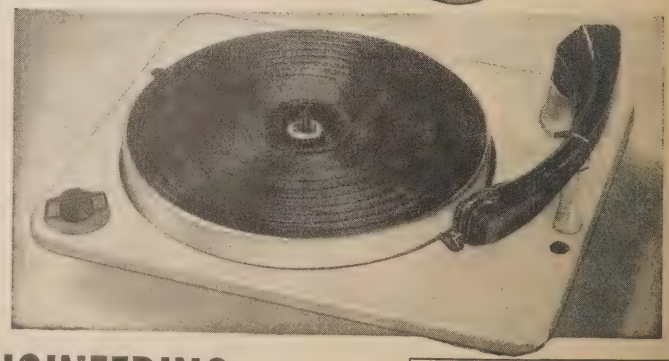

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It might even be argued whether the point itself is always clear.

The G minor is a case in point. It can be played quietly or firmly handled—Jeanette Doyen seems in two minds about it, and seemingly tries to do both.

In the main she handles the piano well, although her technique isn't as sharp as the best of her contemporaries.

She strikes a powerful chord, too, when required, helped by a recording good by today's standards, and phenomenal by those of a few years ago.

It bass has a good quality as opposed to the tubbiness heard in some European recordings.

Its clarity is less good in heavily scored passages, but this may be due to the pianist herself. Apart from a slight tendency to be "muddy," the engineering is very good and the surface not at all objectionable.

I don't know of another disc containing these four Ballades—but it gives you plenty for your money. The original is by Westminster who can always be relied upon for good sound.

★ ★ ★

BIZET—Carmen Suite. L'Arlesienne Suites Nos. 1 and 2. Played by the Bamberg Symphony Orchestra conducted by Marcel Couraud. Vox APL-10, 230.

Carmen is one of the most popular operas, and the music is familiar, in part at least, to almost everybody. This suite contains six numbers from it.

L'Arlesienne is almost unknown as a stage performance, but the nine excerpts which make up these suites are frequently played.

The performance here is not outstanding, but better than average. It is helped by a clear and clean recording, rather reverberant, and not very strong in the bass.

The Adagietto in the first suite which starts the second side suffers from a noticeable tape hiss and the surface at the end of the first side isn't the best.

Musically and technicaly it rates as good average and it is certainly a good deal of popular Bizet to find grouped on a single disc.

★ ★ ★

VIENNA PICTURE BOOK—Played by Karl Grell and his orchestra. Fontana 681 000 TL.

This is a selection of Viennese music played by a very good, popular orchestra, in which singing strings blend with piano, accordion, Hammond organ, guitars, and flutes, etc.

If you read the jacket notes you will see that the intention is to weave the tunes into a tour of Vienna. You are invited to take in a coach which travels a road paved with tourist romance and for which the city is traditionally famous.

The difference is that these are not Strauss waltzes or film numbers; they are old Viennese songs, mostly unfamiliar to me, but amospheric to a degree.

Because the music is so tuneful, the recording good, and the performance living up to its rather fulsome description, you will, I am sure, agree that it delivers exactly what it promises, and which is foreshadowed by the attractive and glamorous cover.

And, if the truth is told, this can't be said of many more ambitious records!

The surface is first class.

WAGNER — Rienzi's Prayer. WEBER—Max's Scene and Aria. Sung by Wolfgang Windegassen with orchestra. DGG 30 226 EPL.

Wagnerian tenors at the moment don't seem to be outstanding in the tradition of Lauritz Melchior, but Windegassen is probably the best known and most popular.

This popularity rests as much on his stage appearance as on his singing. His voice as such lacks a certain heroic ring which has characterised the great voices of the past, and which means a great deal to almost every Wagnerian role.

On the other hand, if he is in fact the best we have, then here he is.

Rienzi is rarely played today, but the Prayer is one of its leading arias. Nor is Der Freischutz any more popular—a pity, for it contains some fine music.

MASCAGNI — Siciliana; Easter Hymn; Ah, il Signor vu manda; Brindisi (Viva il vino Spumeggiante). Sung by Mario del Monaco, Elena Nicolaidi and Aldo Protti with Chorus and Orchestra conducted by Franco Ghione. Decca CEP 509.

I haven't checked the point, but am fairly certain that these excerpts come from the full-length recording of the opera made a year or two ago by Decca.

Monaco, who stars in these selections, has a robust voice of very great power, although there are others who have a more engaging quality.

As Turiddu, the hot-tempered young wine merchant, he is very well cast, for above all things the vitality he expends on the role is quite essential.

The complete opera I thought the best of all those offering, and this must go on the credit side together with the good support he receives.

The recording in general is excellent.

★ ★ ★

BACH ON THE BIGGEST. — Toccata and Fugue in D minor, Wachet Auf! In Dulci Jubilo and Toccata Adagio and Fugue in C major. Played by Robert Elmore on the Auditorium Organ of the Atlantic City Convention Hall. Mercury MG 50127.

This is a recording of what is claimed to be the world's largest organ. With 7 manuals, 1,250 stops, 33,000 pipes and 375,000lb weight it might well be. One pipe is 32ft long, 27in wide and 32 deep. It is the low C Diaphone Profunda and speaks at 8 cycles per second.

It is certain that mammoth organ would be needed to serve an auditorium which seats 42,000 people.

The acoustics of such a place, probably empty, must have staggered the recording engineers. The reverberation time is terrific—listening to the disc you can count off the seconds with ease.

But they have produced a record that sounds just what it is—a tremendously powerful organ in an outsize hall.

The reverberation is a problem in the faster moving passages, and the overhang is considerable. It is not so bad, for instance, in the Adagio of the Toccata, Adagio and Fugue in C, which is the best part of the disc.

Nor is the organ tone as pleasant as it is as heard from some smaller instruments.

But no one can deny that it sounds really big and there is no reason why

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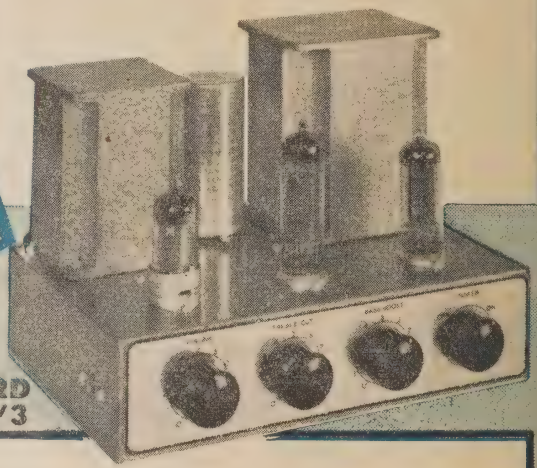

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MENDELSSOHN.—Violin Concerto in E minor Opus 64. MAX BRUCH.—Violin concerto No. 1 in G minor Opus 26. Played by Wolfgang Schneiderhan with the Radio Symphony Orchestra of Berlin and the Bamberg Symphony Orchestra, conducted by Ferenc Fricsay and Ferdinand Leitner. DGG LPEM 19124.

In general, I have liked Schneiderhan's ses—he is such a competent and unannered violinist, with practically no ritation value, conservative and formal many ways, but with excellent musil perception and good if not superlave technical equipment.

He is neither a Heifetz nor an Oisakh, but one doesn't need to be to roduce very good records.

The Mendelssohn is played with all ne things I have mentioned in evidence. he quality I missed most was a touch f direct romanticism which can do so uch to this lovely and frankly roantic concerto.

In the first movement his accuracy, lthough not his intonation, is solidly ixed, and in the slow movement his ne and manner are fined down to an lmost slender line, ethereal rather than arm.

There is no lack of fire in the sparkng finale, one of the best in all violin usic, although there are a few spots, s in most versions, where his technical esources are used in full.

The Max Bruch has quite a different ound to it. The violin is recorded more losely and, therefore, has more apparnt power, particularly in the lower trings which are so freely used.

The orchestra, too, has more body o it.

There is no lack of sentiment in the low movement, but one must be resigned to that, and the customers look or it. There is some beautiful playing ere, not only from the violinist but rom the orchestra as well.

It is not completely clear from the acket notes which orchestra is which so must take its commendation on a 50-0 chance.

If I don't rate the Mendelssohn quite t the top, I liked the Max Bruch as nuch as most contemporaries.

In general rating, therefore, I would ay this is a good, if not outstanding, disc n a field where few are above criticism.

The surface is very good.

★ ★ ★

BRAHMS—Symphony No. 1 in C minor, Opus 68; Tragic Overture, Opus 81. Played by the Philharmonic Promenade Orchestra conducted by Sir Adrian Boult. Nixa NCL 16000.

BRAHMS—Symphony No. 2 in D major, Opus 73; Academic Festival Overture, Opus 80. Played by the Philharmonic Promenade Orchestra conducted by Sir Adrian Boult. Nixa NCL 16001.

BRAHMS—Symphony No. 4 in E minor, Opus 98; Variations on a Theme of Haydn, Opus 56a. Played by the Philharmonic Promenade Orchestra conducted by Sir Adrian Boult. Nixa NCL 16003.

As far as Brahms is concerned, this performance is just about as straightforward as one could imagine. It is a reliable, sensible version, in which the music is guided along with no desire or attempt to lure it into unusual forms or places.

As a result we get a consistently shaped symphony, which, if it won't win any spectacular awards, will win friends and certainly won't offend any of the old ones.

Often it is magnificent.

The recording isn't of the same standard, nor has it the equal impact, of the Planets, another outstanding Boult release of some years ago, but it is very good in a full-blooded style.

In this respect it is equal to any contemporary, although not as smooth or sophisticated as Klemperer's for Columbia.

Most recordings of this symphony have trouble in taming the edge of the violins, particularly in the first movement, and I found this one sounded best with the EMI curve and even an extra notch of treble cut. Some bass boost evened up the balance very well, and the end result was clear, forward and full bodied.

My only real criticism concerns surface noise which can be heard through quiet passages.

It is present, too, with the second and fourth symphonies which Nixa released some months ago.

Both these have the same general character as the first and were obviously made at the same time.

In all cases, their solid sincerity makes them wear well. Some sections, such as the first movement of the Second, I liked as well as any version in the catalogue.

The addition of an extra work on each disc is an advantage not to be overlooked in the face of such reliable performances.

★ ★ ★

FERDE GROFE—Grand Canyon Suite. Played by the Philadelphia Orchestra conducted by Eugene Ormandy. Coronet KLL 591.

Ferde Grofe's vivid and colourful set of sketches is not usually favoured by pedants, who received a shock when Toscanini dignified it with a marvellous recording some years ago.

There is little doubt that it is the composer's most popular work (his orchestration of Gershwin's Rhapsody in Blue doesn't count) and there is little doubt also that it will hold its solid entrenchment in the list of American classics.

Judged as a recording this is certainly the best there is.

The recent batch of Philadelphia discs has never been bettered in its history and this one is in the top flight.

Listen to the incredibly fine instrumental interplay in the Painted Desert, for instance—demonstration stuff if ever I heard it.

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Ormandy as usual has made it a luxurious and glamorous performance, something to admire and wonder at.

And why not? The Grand Canyon is a miraculous piece of strong colour even in repose, and I'm sure Grofe meant it that way.

Toscanini made of it a more subtle and firmly conceived picture. He is much the better when handling the glimmer and warm burst of the Sunrise, for

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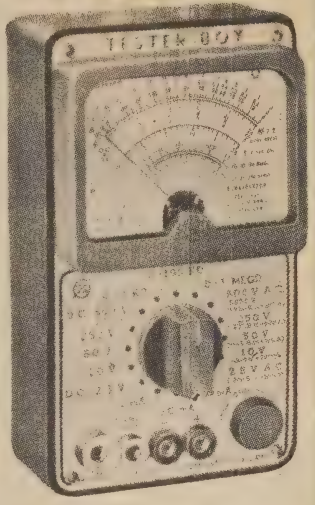

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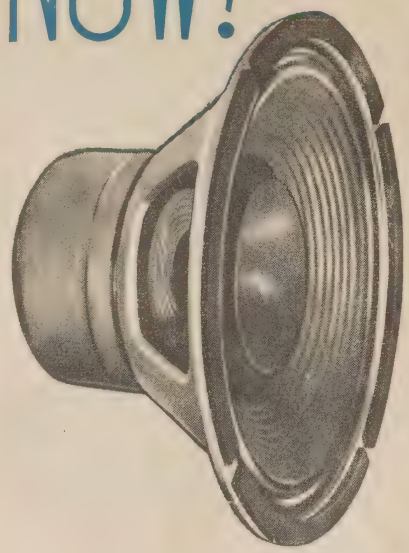

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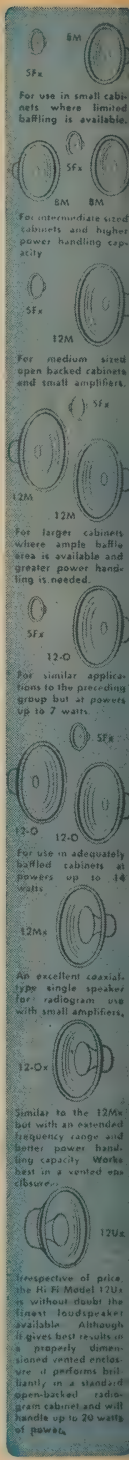
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ıance, where Ormandy is much too
ious to operate his purple stops.
But if Ormandy doesn't mix his ma-
ials with the same skill, he controls
s splendid forces with such gorgeous
ect that even the Cloudburst is nar-
rvly saved from vulgarity.
Both frequency and dynamic ranges
e exceptional, although some discretion
s been exercised with the gain control
the end of side 2, and with reason.
e surface is excellent.
I'm giving this disc my top award, if
ly because I can applaud superb re-
rding when I hear it.

* * *

TCHAIKOVSKY — Serenade for Strings in C major; BORODIN—Nocturne; BARBER—Adagio for Strings, Opus 11; VAUGHAN WILLIAMS—Greensleeves. Played by the Strings of the Philadelphia Orchestra conducted by Eugene Ormandy. Coronet KLC 634.

The Philadelphia Strings have always
en famous and can be expected to
their best in music written for strings
one.
And so they do here, but with vari-
le success.
The Borodin Nocturne, a lovely move-
ent from a string quartet, is stated by
e first violins with an extraordinary
hemence and passion, so much so that
e recording process only just accom-
odates it.

It sets a style of brilliance and sharp ness which is quite electrical to hear, but which orchestrally gives the music a character much more robust than the original version.

The arrangement was most successful in glamorising the music, and Ormandy has to an even greater degree glamorised the arrangement.

As a means for displaying orchestral colour it is the best on the disc, and one of the best the Philadelphia has recorded.

Barber's Adagio gives the strings a chance to exhibit their power and persistence in building and holding sustained passages, highly and romantically charged. Good, but like most of the disc, it is overstated.

The Serenade for Strings is an example of high colour and technical power.

It must become rather monotonous to comment upon these characteristics of the Philadelphia orchestra, but invariably they are responsible for most of what it has to give. No other orchestra recording today has such a clearly defined personality which permeates all its work.

Again, there is magnificent playing.

The recording on this side has a different sound from that of the first, and it isn't so clear. Some of the full passages as in the final section are muddy by comparison with the rest.

The frequency range is good, and the dynamic range exceptional. The surface has a few crackles.

FINE RELEASE OF MAHLER SECOND

MAHLER — Symphony No. 2 in C minor "Resurrection." Played by the New York Philharmonic Orchestra conducted by Bruno Walter with Emilia Cundari, Maureen Forrester and the Westminster Choir. Coronet KLC 2683-4.

This huge symphony, which takes up
our full sides, is not often recorded —
t fact I cannot remember more than
ne other in recent years.
Its name gives an accurate key to its
rogram. It is a long discourse on life
nd death, or more accurately on death
nd life. The last two choral movements
ortray the exultant rebirth of the hero
hich follows the long dirge-like first
ovement and the spiritual and emotion-
l progress of the second and third.
Mahler was not a symphonist in the
radition of those who went before him.
His emotional and philosophical outlook
vas cast in an enormous pattern — much
oo large for the ideas he used to express
.
Just as Mahler was a dedicated man
n his music, so one needs to be touched
vith something of the same dedication
o follow his purpose completely, not be-
ause it is in any way obscure but be-
ause such an outlook is necessary to
ustain one on the journey.
The tempo of modern life is against
xtending the experience for the best
art of two hours.
I do not offer these fairly conven-
ional remarks as criticism but rather as
omment to guide those who do not
now the symphony.
Others will have their own opinions
bout the work and will be more inter-
sted to know how it is performed.

Fortunately my report here is of unreserved praise.

Bruno Walter in his youth enjoyed close personal contact with Mahler and, as the accompanying notes reveal, was a deep admirer of his work. He confesses to a life-long devotion to this symphony, and every note here bears out his ambition to produce a superlative performance.

All his efforts, plus those of the performers, have that dedicated quality I have already mentioned. Everything is subservient to the music.

Two of the finest moments are the contralto's solo in the fourth movement and the quiet introduction of the choir in the fifth.

These give forth the composer's message even more vividly in their own restraint than all the cataclysmic sound which the huge orchestra can build.

For one feels that Mahler continues with great vehemence often after he has well made his point, carried along with a torrent he cannot adequately control.

The recording is of very high quality. Its balance, despite the great dynamic range and prodigal demands on frequency, is splendid. All round I thought the engineering first class.

Surface noise is higher than it should be on some sides, but the cutting amplitude is high and only rarely does it get the opportunity to offend a critical listener.

I can't imagine a better version than this being produced for a long time.

It has an attractive double folder with notes by Bruno Walter and a full analysis.

Available soon

TWO NEW "GELOSO" VFO'S

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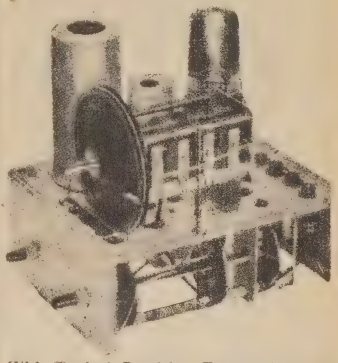
144 to 148 megacycles, using two 6CL6s as oscillator-multipliers, one 12AT7 as multiplier and 5763 amplifier: sufficient drive for 832 or 2E26 amplifier stage. The 4/103 v.f.o. provides netting facilities with switching to crystal operation for established communication.
Price not known yet but is expected to be at the well-known attractive price of all other Geloso products.

MODEL 4/104:
New six-band v.f.o. including the 11 mx band. Covers 80, 40, 20, 15, 11 and 10 mx. Uses 6CL6 osc. driving 5763 amp.; sufficient drive for 807 or 6146 p.a. stage.

MODEL 4/102:
The 4/102 has now superseded the 4/401. The 4/102 is a five-band v.f.o. covering 80, 40, 20, 15 and 10 mx using 6L6 amp. providing sufficient drive for higher powered push-pull, push-push and single-ended finals.



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- Continuous frequency coverage from 1.7 Mc. to 250 Mc.
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Rated for a max. 1.20v D.C. at 300mA input. Higher voltages on c.w. and s.s.b.
For max. efficiency the 10-metre coil is made of 9/16in silver-plated strip, 15 and 20-metre coils of 1/8in silver-plated wire, and the 40 and 80-metre coils of 12 B. and S. tinned-copper wire.
Input capacity 250 pF. max., output capacity 1,500 pF. max. A single pole five-position switch is provided which can be used for switching in parallel capacities when required.
Recommended input capacitor: Eddystone Type 817. Recommended output capacitor: Standard miniature 3-gang BC condenser which is suitable in this position up to 1 kw

Price: £4/17/6 nett.

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WILLIS PI-COUPLER CHOKES. 150 watts heavy duty tx type, as recommended in A.R.R.L. Handbook: constructed on high quality ceramic former: operates all bands up to 30 mC.; insulated for 3,000v. .. .. **25/- each**

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SHORT-WAVE NOTES BY ART CUSHEN

HIGHER POWER FOR ELWA

One of the most popular African stations ELWA, in Monrovia, Liberia will soon increase power to 50,000 watts.

THE news that another missionary broadcaster will increase power to 50,000 watts has been received from E.L.W.A., which is operating from Monrovia in Liberia. This station has been only on the air for a matter of four years but it has been heard in this area on at least two of its normal operating frequencies.

The station, which is controlled by the Sudan Inland Mission, has the whole of North Africa as its target area and the new transmitter to be put into service next year is expected to increase this area to cover the whole Middle East.

The station has a service to West Africa and this is on the air 4.45- 7.15 p.m. and on Sundays from 5.15 to 8.45 p.m. on 4770 Kc with 10.000 watts, and on 21530 Kc with 500 watts. The station has a session in English 5.45 to 7.00 a.m. and 7.00 to 7.45 a.m. in French on 4770 Kc. The station also uses the new frequency of 11740 Kc, replacing 11985 Kc, and this outlet is in service from 3.30 to 4.30 p.m. in English, and 2.00 to 5.30 a.m. in English, French and Arabic. This service is on 25,255 Kc with 2000 watts, as well as the 10,000-watt transmission on 11740 Kc. The service to North America is now on the air on Wednesdays 8.55 to 10.45 a.m. on 15120 and 21535 Kc, and 10.55 a.m. to 12.45 p.m. on 11745 and 21535 Kc.

MALAGACHE REPUBLIC

The broadcasts from the former Madagascar stations which is now known as the Malagache Republic are now well received on several frequencies. The transmission in French is on the air from 1.30 to 3.30 p.m., 7.00 to 9.00 p.m., 1.00 and 5.30 a.m. on 5016 Kc with 5.000 watts, 6172 Kc 1.000 watts, 7260 Kc 4.000 watts, 9515 Kc 1.000 watts. Broadcasts from Radio Tananarive are also in Malagachi language, 1.30 to 3.30 p.m., 6.20 to 8.30 p.m., midnight to 3.00 a.m. on 3386 Kc 1.000 watts, 7155 Kc 1.000 watts.

ECUADOR SCHEDULES

THE broadcasts from Ecuadorian stations as well as undergoing changes in call signs have also, in many cases, gone on increased schedules. The broadcasts from many of these low-powered stations are best received in our summer months, when signals are heard in the 60 and 49 metre bands in the late evenings, when the stations are commencing the morning programs. The Manta station on 4815 Kc, using 1,000 watts, broadcasts from 10.30 to 12.30 a.m., and from 2.00 to 6.00 a.m., and 8.30 a.m. to 2.00 p.m.

HCJO1 Radio Quito is operating from 9.15 p.m to 2.30 p.m. using 4923 Kc with 1.000 watts. Radio Quito has the mailing address of Apartado 57, Quito. HC1G 5 Ondas Azul e Casiaan 4980 broadcasts from Cuenca from 8.45 p.m. to 2.30 p.m. with the power of 1.000 watts.

Radio Manta, with the address of Apartado 4869, broadcasts on 6015 with the callsign HCIX4. The station has the power of 1.000 watts and broadcasts from 10.00 p.m. to 2.00 p.m. La Voz del Democrocia, which has the address of Apartado 288 in Quito has the schedule of 9.30 p.m. to 2.30 p.m. and uses 1,000 watts on 6060 Kc.

AMBON ON 7140Kc

THE reception of Radio Republic Indonesia transmissions on 7140 Kc from 7.15 p.m. has been good in this area, though the identification of the exact location of the station has not been possible. A report from the Japanese Short-Wave Club places the site of the station at Ambon in the Moluccas, and that the station also operates on 4840.

The station has been heard from 7.15 p.m. to sign off at 1.30 a.m. Broadcasts from Palembang in Sumatra have been noted on 4865 Kc to sign off at 2.00 a.m.

Thai national programs have appeared on the frequency of 7300 Kc, and on this frequency it is reported from 10.00 p.m. to 1.30 a.m.

NEW PRAGUE FREQUENCIES

THE transmissions of the Czechoslovak Radio to North America and to Australia and New Zealand have undergone some alterations for the summer months. Two new frequencies, those of 9685 and 11745 Kc, have been put into service. The North America broadcasts at 10.30 a.m. are on 9550, 11725, 11745, 11840, 15280 Kc. The transmissions at 1.00 and 3.00 p.m. are carried on 7255, 9550, 9605, 11725, and 11745 Kc. The Australasian service is on 11720, 15185 and 21450 Kc from 6.30 p.m. These stations are assigned the followine callsigns. OLR8L 7255, OLR3A 9550, OLR3G 9605, OLR4E 11725, OLR4F 11745, OLR4A 11840, OLR5I 15175, OLR5H 15285 and OLR7A 21450

POPULARITY POLL

THE customary poll to find the most popular shortwave broadcaster will be held in the next two months. The poll is conducted each three years by the International Short-Wave Club of London.

Readers are asked to list the five most popular short-wave stations in order of their own favouritism, and also to write in a few words why the choice is given to the number one station.

A postcard or letter should be sent to the International Short-Wave Club at 100 Adams Gardens Estate, London SE16, England. We will announce the results in this page when they are available and the votes from readers will be appreciated by Arthur E. Bear the Secretary of I.S.W.C. Votes should be sent to the Club to be received by the end of January, 1959.

NOTES from readers should be sent to ARTHUR CUSHEN, 212 Earn Street, Invercargill, NZ. All times are Australian Eastern Standard.

HAITI FREQUENCIES

THE broadcasts from Cap Haitian in Haiti, which are of missionary nature, have undergone two frequency changes. The station 4VWI is now operating on 17717 Kc from 10 a.m. to after 12.50 p.m. The 4VLH transmitter, which has been in the vicinity of 9620 Kc for some months, has been heard on 9770 Kc in the broadcast, which opens at 7 p.m. During the afternoons, the station has been observed on 9760 Kc the drop in frequency being made in order to clear the interference from the London signal which at that hour uses 9770 Kc.

FLASHES FROM EVERYWHERE

THAILAND has a Territorial Defence station in Bangkok which has been heard on 4840 Kc and it has been heard from 12.45 a.m. to 1.30 a.m. The station has a news bulletin or a talk in Thai featured at 1.00 a.m., while the station closes its transmission with the Thai Anthem. This signal is close to the Thai National station which has also been heard on 4830 Kc, with the relay of the home programs.

BRAZILIAN station Radio Olinda Pernanbuco operates with the following schedule on XYK8 on 3376 Kc. from 6.45 p.m. to 1.00 p.m. The address of this station is Ciaxa Postal 1313 Recife. Radio Sociedad Farroupilha has been announcing as using the shortwave frequencies of 9770 and 15335 Kc, reports World Radio Handbook bulletin.

HONDURAS is the site of a new station heard till closing at 3.55 p.m. The station has the slogan Radio Concordia and is on 6140 Kc.

Radio Tegucigalpa in Honduras, has been noted on 6545 Kc, when closing at 3.12 p.m. and in a verification it is stated power will be increased to 3000 watts.

LOURENCO MARQUES, home of the Radio Club of Mozambique, in its English commercial service to South Africa, Rhodesia, Nyasaland and Belgian Congo, is broadcasting 1.30 to 7.00 a.m. and to 8.00 a.m. on Sunday. The transmission is carried for portions of the activities for the day on several frequencies. The 3221 Kc station is on the air 1.30 to 7.00 a.m., on 4925 Kc the service is 1.00 a.m. to 7.00 a.m. also. On 7250 Kc the transmission is 1.30 p.m. to 7.00 a.m. On 9616 Kc broadcasts are from 3.00 p.m. to 2.00 a.m. and on 11770 Kc 1.30 p.m. to 5.00 a.m.

MANILA station of the Far East Broadcasting Company is now reported to be testing on the two assigned frequencies of 11920 and 15385 Kc. The station is on the air from 6.30 to 12.30 on 11920 Kc and from 12.30 to 1 p.m. on 15385 Kc. This transmission is beamed north.

From 11.00 p.m. to 12.30 a.m. the test is on either of the two frequencies, and the transmissions are beamed westerly. From 5.30 to 6.30 a.m. the station uses 11920 Kc, and from 6.30 to 8.00 a.m. the signal is again carried on 15385 Kc, with transmissions beamed in a southerly direction.

WINDWARD ISLAND is reported from the United States with test transmissions on 11978 Kc at noon and later it was heard on 15070 Kc with another period of test broadcasts. The only signal from Grenada which we are at present hearing is on 17915 Kc at 8.00 a.m., but strength is weak and should improve during the summer.

BELGIAN CONGO station Radio Congo Belge, which is located at Elizabethville, has appeared on 5940 Kc, having moved from 6030 Kc. The reception in the Middle East from where this report originates, states signals are heard from 2.15 a.m. to 10.30 a.m. on the 5940 Kc frequency program of African music with announcements in French has been noted on the frequency from 4.15 to 4.45 a.m.

ANGOLA station Radio Emisora Official at Luanda, which was recently reported on this page as using 17795 Kc with CR6RZ, has been heard in California. The station has been heard from 8.00 a.m. to sign off at 8.30 a.m. The station was formerly broadcasting on 11860 Kc.

KARACHI, in the broadcasts of Radio Pakistan, has made some frequency changes to improve reception in the Middle East and United Kingdom, reports the International Short-Wave Club. The broadcast to Iran is from 2.00 to 2.45 a.m. on 5980 Kc. Turkish programmes from 4.15 to 5.00 a.m. on 11670, 15205 Kc, while the same frequencies are used for English broadcasts from 5.15 to 6.00 a.m.

DAMASCUS station of the United Arabic Republic broadcasting from Syria has English programs from 5.30 to 6.30 a.m. The station is using 15145 Kc and English news is at 6.15 a.m.

TANGIER stations continue to be reported of good strength. The WTAN broadcasts in English 6.30 to 8.45 a.m. on 9456 Kc, I.B.R.A. Radio, which uses 9275 Kc, 11510 Kc and 14881 Kc, has also been heard in various languages. English from 7.15 to 7.45 a.m., and this is followed by Swedish. The station then opens at 8.00 a.m. with the programs of Radio Inter Africa.

BRUSSELS, the site of the Belgian National Radio, is reported to have made a change in frequency in the 13-metre band. The former channel of 21510 Kc has been replaced by 21530 Kc, and the callsign is ORU5. The station operates from 8.00 to 10.00 p.m., 10.15 to 11.00 p.m., and 11.00 p.m. to 2.45 a.m.

POPULAR MUSIC PROGAMS FROM U.S.A.

The recent retiming of the popular Music USA programs has resulted in the sending of the special service to Australia and New Zealand, and the inclusion of our listening in the Far East service. The time of this broadcast is too late for evening listening in both Australia and New Zealand. A Cooma, N.S.W. reader requests the new schedule of the Voice of America for this program, which has been reduced from two one hour programs to two of 45 minutes duration and the other 15 minute periods being devoted to news.

TRANSMISSION: 1. 12.15 to 1.00 a.m., 1.15 to 2.00 a.m. 9650, 11775 (Honolulu): 11790 (Manila): 7160 9745 (Okinawa) to East Asia. 6120 (North Luzon) to Indonesia Australia, 15185 (North Luzon) to South and South East Asia, 15330 (North Luzon) to South Asia.

AMATEUR BANDS WITH BILL MOORE

Many of the regulations covering the operation of Amateur Radio Stations are of International origin and are arranged at International Telecommunications conferences. The basic limitations of operation are thus common to amateur stations throughout the world.

SINCE the 1959 Geneva ITU Conference is well in the news some of the International regulations affecting amateur radio operation gazetted after the Atlantic City Conference held in 1947 may be of interest.

The actual regulations of course cover all radio services, but many of the rules under which we operate are not local restrictions but are laid down in these international regulations.

The spectrum covered are electromagnetic waves between 10 Kc/s and 3,000,000 Mc/s. The listed definition of the amateur service is as follows:-

"A service of self training inter communication and technical investigation carried out by amateurs, that is by duly authorised persons interested in radio techniques solely with a personal aim and without pecuniary interest."

Regulations expressly covering amateurs include the following:-

Any person operating the apparatus in an amateur station must have proved that he is able to transmit and receive by ear texts in morse code signals (there is frequency limitation).

In order that identification of stations may be as rapid as possible, stations provided with callsigns must unless the regulations provide otherwise transmit this call-sign during the course of their transmission as frequently as is practical and reasonable.

No transmitting station may be established or operated by a private person or by an enterprise without a licence issued by the Government of the country to which the station in question is subject.

SECRECY

The holder of a licence is required to preserve the secrecy of telecommunications as provided in Article 32 of the convention. Moreover the licence must provide that if the station includes a receiver, the interception of radio-communication correspondence other than which the station is authorised to receive, is forbidden, and that in the case where such correspondence is involuntarily received it must not be reproduced, nor communicated to third parties, nor used for any purpose and even its existence must not be disclosed.

Radio communication between amateur stations of different countries shall be forbidden if the administration of one of the countries concerned has notified that it objects to such radio communication.

When transmissions between amateur stations of different countries are permitted they must be in plain language and must be limited to messages of a technical nature relating to tests and to remarks of a personal character for which, by reason of their unimportance, recourse to the public telecommunication service is not justified. It is absolutely forbidden for amateur stations to be used for transmitting international communications on behalf of third parties.

Administrations shall take such measures as they judge necessary to verify the qualifications from a technical viewpoint of any person operating the apparatus of an amateur station.

The maximum power of amateur stations shall be fixed by the administration concerned having regard to the technical qualifications of the operators and to the conditions under which they operate.

All the general rules of the convention and of the present regulations shall apply to amateur stations.

In particular the transmitting frequency must be as constant and as free from harmonics as the state of technical development for stations of this nature permits.

During the course of their transmissions amateur stations must transmit their call-signs at short intervals.

From the above extracts it will be clearly seen that most of the P.M.G. regulations covering amateur operation are of international origin and national licencing authorities are bound by the ITU decisions.

GODESBURG MEETING

THE IARU Region 3 Bad Godesburg Conference discussed fully all regulatory problems and set a plan of action for delegates from National Amateur Bodies attending the 1959 Geneva ITU Conference.

Other interesting features that arose from the Discussions included a proposal to conduct International Fox Hunts.

Most of the Fox Hunts these days held in Australia are confined to the 144 Mc/s band. It would appear that the most popular band in Europe for these events is 3.5 Mc/s.

The Swedish Society prepared a paper dealing with organisation of fox hunts at an International level which may lead to European Championship.

In Great Britain the top band 1.7 Mc/s is used practically exclusively for Fox Hunts. Amateurs in the U.S.A. generally choose the frequency band most used in their particular location and these hunts are evenly distributed over the 3.5, 28, 50 and 144 Mc/s bands throughout the country.

National Societies in Europe foster these hunts to encourage interest amongst the younger members and they are one of the only activities that could be classified as a sporting event. They also provide a valuable source of publicity for the radio amateur movement.

Another paper presented at the conference drew attention to the potentiality of the world's 250,000 radio amateurs as ambassadors of international good will.

It was suggested that the movement should be encouraged by the United Nations. No other hobby provides the opportunity of knowing the peoples of other nations in their homes and the opportunity of fostering friendship.

It was agreed that IARU HQ should be requested to ask United Nations to give all possible support to amateur radio.

Public Relations were covered in a paper prepared by the Swedish Society. A very strong argument was put forward for a concerted effort to place the work of radio amateurs before the public.

Public support must assist National Societies in their work and general liaison with Governmental authorities. It was decided to appoint a public relations officer for IARU Societies in Region 3.

COMMERCIAL DX

DUE publicity is being given overseas to the concerted efforts of some of the DX-pedition organisers to extract money for these ventures from the amateur fraternity.

Letters soliciting cash donations are being circulated among amateurs in the U.S. and one amateur describes the process as a racket. He points out that the cash donation covers the issuing of a Q.S.L. card and the difficulties of obtaining one if a donation is not made.

The general idea is if an amateur wants some fun in the way of operating under an exclusive prefix he should be prepared to pay for it.

BLUE MTS. FIELD DAY

OVER 100 persons gathered at the Catalina Park, Katoomba, Field Day of the Blue Mountains Section of the WIA. The mountains turned on a glorious spring day, but even then the wind was cold for some of the seaside residents.

Bill Hall, VK2XT, and Ern Baker, VK2FP, with their wives, journeyed from Newcastle, and Major Collett, VK2RU, and wife, from Gosford. From the west came Nev Wilde, VK2DR, and family, from Blayney. Jack Turner, VK2AJQ. Vic Cole, VK2VI, came from Bathurst.

Calls signs registered included VK2AVK, 2ASZ, 2NK, 2ACP, 2ART, 2MZ, 2RM, 2ZCF, 2QA, 2ZBG, 2AWZ, 2ZAV, 2ZCP, 2ZBX, 2AJQ, 2ZAC, 2ZDI, 2HZ, 2SG, 2WI, 2DR, 2OA, 2AOQ, 2APQ, 2OT, 2ALJ, 2BQ, 2XT, 2FP, 2ABK, 2RU, 2VL, 2AVW, 2ARG, 2YR, 2IX, 2ZCW, 2FH, 2ABU, 2ER, 2PM.

All the field events were well supported and the blindfold transmitter hunt was very popular, with the usual number of competitors off the beam and in the bush.

Results of the competitions conducted were as follows:—

Identifying 12 valves of varying vintages: A tie between Max Sobels, VK2OT, and Bob Winch, VK2OA. They each listed seven correctly. Guessing the frequency of an L/C circuit saw Wally Harmon with the closest answer.

Dave Andrews, VK2AWZ, took only 25 minutes to locate the 144 Mc/s hidden transmitter—an excellent performance considering the difficult location. Dave won the cup, Ron Graham, VK2ZBG, was second in 35 minutes, and Bob Winch, VK2OA, third in 40 minutes.

The 144 Mc/s scramble event resulted in a three-way tie with Dave Andrews, VK2AWZ, John Peel, VK2WJ, and Dick Norman, VK2ZCF, all making 15 contacts. Dick, 2ZCF, won the cup on a count-back.

Jack Turner, VK2AJQ, won the 7 Mc/s scramble and cup, the event running simultaneously with 144 Mc/s scramble. Max Lear, VK2ASZ, was second, and Nev Wilde, VK2DR, third.

A SWL, Viktor Skrypka, edged out all the licensed amateurs in the blindfold hunt final while Beverley Cole won the ladies' section, Judith Adams, the girls', and Terry Pinning, the boys' section.

Section chairman Wal Cromie, VK2MZ, presented the prizes at the completion of the outing and State President Pierce Healy, VK2APQ, spoke on divisional and ITU arrangements.

The success of the day was mainly due to the work of the chairman, Syd Williams, VK2AVK, Norm Durham, VK2OA, and Bob Lear, VK2ASZ, and his wife, the latter in charge of registration.

N.S.W. MEETING

TO an assembly of over 130 members (an all time record) John Moyle, VK2IU, lectured at the October meeting of the N.S.W. Division the subject "Stereophonic Sound." He illustrated by sketches the recording processes for the special discs and explained the theory and advantages of this audio system.

The demonstration that followed using two Goodman speakers in vented enclosures clearly showed the value of the system for Hi Fi enthusiasts.

The meeting was also notable as the 1,000th member was elected to the Division. This honour was reserved for the Canberra Radio Society which has become affiliated with the Division. The final figure for the evening was 1,009. Of these nearly 700 comprise transmitting members and cover nearly two-thirds of the licensed radio amateurs in N.S.W.

IMPORTANT WICEN OPERATION SUCCESS

THE most important N.S.W. WICEN exercise yet conducted was held on the evening of Tuesday, November 4. Civil Defence Controllers throughout N.S.W. country areas on this occasion spoke with the Civil Defence Headquarters Staff in Sydney, via the Wireless Institute Civil Emergency Net. Net members had arranged for the controller to be present in their shack for the exercise. It provided an opportunity for these region officers to hear the net in operation and judge its value in an emergency.

The VK2WI transmitters at Dural were used for control and operated simultaneously on 3573 and 7050 Kcs. VK2WI was remotely controlled from Civil Defence Headquarters in Kent Street, Sydney, via a 57.6 Mc/s link over a distance of 25 miles. A further link on 145 Mc/s was used to feed the 3.5 and 7 Mc/s received signals back to Kent Street.

At H.Q. was WIA State Emergency Co-ordinator Bob Godsall, VK2ARG, and State President Pierce Healy, VK2APQ.

Major-General I. Dougherty, State Controller of Civil Defence, spoke over the net and thanked radio amateurs and the WIA for the help they were giving the C.D.O., in communication, a most important section of their work.

Communications Officer Major Allan Grant also reviewed the exercise and mentioned the members of the C.D.O. who were present at H.Q.

WICEN stations in the five country areas were called in and asked to report whether they had C.D. personnel present. As a result some 20 regional and local C.D. officers spoke on their reactions to the exercise.

Conditions were particularly poor on both the 3.5 and 7 Mc bands; despite this fact and the heavy QRN, the occasion was a complete success.

The links and remote control of VK2WI were particularly impressive. Station engineer Dave Duff, VK2EO, and Bob, VK2ARG, should be particularly pleased with results, and must be congratulated on their work.

At the conclusion of the tests at C.D.O. H.Q., the whole proceedings were discussed from the communication and technical aspects.

RADIO IN SECONDARY SCHOOLS

All secondary schools in N.S.W. have been circularised by letter from the Deputy Director of Secondary Education, setting out the facilities in radio instruction provided by the Wireless Institute of Australia, N.S.W. Division.

The information provided tells of the class and correspondence course run by the division and advising schoolchildren how to direct inquiries.

Already a number of schools and individuals have requested information as a result of the circular.

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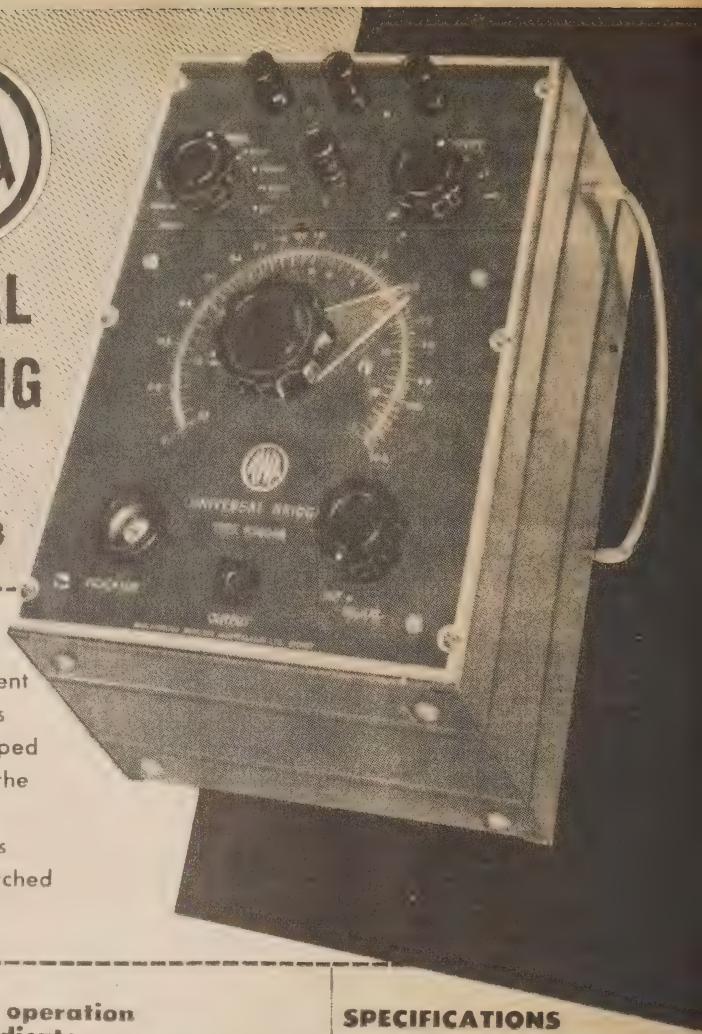
TYPE **A56048**



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FEATURES

- **Simplicity of operation**
- **Magic eye indicator**
- **Built-in self-checking system**
- **"Open bridge" position allows use of external standards**
- **Provision for use with external frequency source**

Price £30/10/- *(plus tax)*

SPECIFICATIONS

Resistance Range:	0.1 to 10M.
Capacitance Range:	10 uuf to 10 uF.
Inductance Range:	Comparative Measurements above 1mH.
Comparative Measurements:	Ratio 0.1 to 10.0 with switch on "EXT" Ratio 0.8 to 1.25 with range switch on "%" (−20% to +25%).

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HIGH STABILITY VFO

In order to eliminate the problems of TVI on some of the lower frequency TV bands described in the September issue of the RSGB Bulletin is a high stability 72 Mc VFO.

Designed for 144 Mc/s drive, the oscillator uses a 12AT7 in a "Kalitron" circuit with a stabilised power supply. Frequency drift over the first 10 minutes of operation is some 20 Kc/s at 144 Mc/s but after this period variation over a two hour test was over 500 cycles maximum.

The unit according to these measured figures is as stable as the low frequency crystals normally used in 144 Mc transmitters.

There are some drawbacks in practical use however, as the oscillator has to be effectively isolated from the driver stages. In the unit described a 6V6 stage, buffer amplifier using EF50s on 72 Mc/s drives a doubler to 144 Mc/s.

Apropos the U.S. reactions to the use of VFOs on the 144 Mc/s band mentioned recently, similar views on the subject exist in Europe. At the Region 3 conference it was suggested that VFOs should be used only for "Zeroing" and for breaking into contacts when absolutely necessary. The ordinary operating frequency control should be by crystal and this mode should be used again as soon as possible.

DX ON 50 MC

THE 50 Mc gang in Queensland and Northern N.S.W. have been enjoying plenty of JA DX contacts besides an odd interstate opening. The band during the last two months has practically daily provided JA signals and in mid October were heard as far south as Forbes by VK2WH. The Z call gang in the north have been making excellent JA contacts.

According to reports a VK5 was heard testing on 50 Mc in San Francisco, no details are available.

THE 49th STATE

AT various stages in the last 20 years as a matter of political expediency Australia has been referred to as the 49th State of the U.S.A.

A ballot to be held in late November should see Alaska in that position

This really means that in the future, amateurs qualifying for the ARRL WAS award will have to produce a card from 49 States. Actually the addition of Alaska to the list will not create any difficulty to seekers of the award.

There are 500 KL7 stations active and the possibility of contacts would be greater than say with amateurs in Delaware, Nevada or Wyoming. KL7s are readily contacted from here on bands 14 Mc/s and below.

If you qualify for the award in the near future it would be best to include a KL7 card to ensure the certificate is granted. The additional card will become a necessity immediately Alaska is gazetted as the 49th State, possibly before the end of 1958.

Incidently during 1957-58 80,640 QSL cards were examined by ARRL Headquarters from applicants for WAS awards and 1,452 certificates were issued during the year.

For other operating awards 113,381 cards were checked for DXCC endorsements and new certificate issues. Over 5,000 rag chewers certificates were dispatched to applicants.

GENERAL NOTES

THE old 9S4s are now signing the prefix DL8. Well-known DX-er 9S4AX is now DL8AX.

ST2AR is back in Great Britain after a DX working session on 21 Mc/s from the Sudan. Inquiries, reference QSL cards, should be directed to 119 Raeburn Avenue, Surbiton, Surrey, England.

A special amateur radio station using the callsign ZL1PPJ will be transmitting during the Boy Scout Pan Pacific Jamboree to be held in Auckland from January 3 to January 10, 1959. The N.Z.A.R.T. will operate the equipment and it is expected that transmitters will work on all bands, 3.5 through 144 Mc/s from 2100 to 0900 hrs. G.M.T., daily.

Radio amateurs throughout the world, particularly those connected with the Boy Scout movement, are invited to make "skeds."

These can be arranged by contacting ZL1 stations in Auckland or by writing direct to N.Z.A.R.T. president, Jack Freeman, ZL1VA, Box 9138, Auckland, SE1, New Zealand.

The estimated amateur radio world population is now 250,000 and is growing rapidly. 500 out of a total of 700 candidates were successful at the City and Guilds of London Institute's Radio and Amateur examination. An analysis of the results showed that a high percentage of the unsuccessful candidates had not attended any course of instruction.

Many educational centres throughout the British Isles offer instruction for the Radio Amateur Examination. Here in Australia most intending amateurs enrol for a suitable course.

'NOVA'-COLLARO

All Collaro and Nova features combined!

The range of the NOVATAPE Recorders now incorporates an entirely new model, a NOVA Precision-built Recorder incorporating the world-famous Collaro Deck Mark IV. The features incorporate:

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STOP PRESS To Clear. Not many left!
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Guaranteed frequency response.
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50c/s-15Kc/s 12 VOLT 4½x3¾x4 £34

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6 x 9 or 12in Speaker
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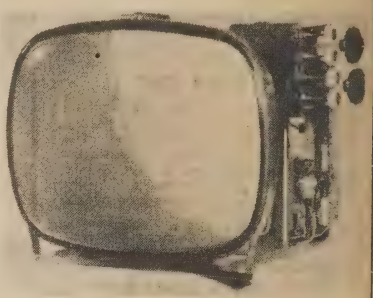

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Separate control box and RF Amp. £6 extra

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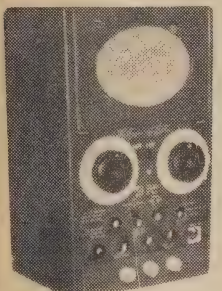

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VR65A/SP41	2/6	6G8	15/
KT66	27/6	6B8	12/6
6X5	10/	807	15/
6V6	12/6	EL3NG	12/6
1Q5	2/6	83	10/
6E5	12/6	EM1	12/6
12K8	12/6	866A	15/
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Chassis including Aerial and Swiver and Circuit No valves

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The new patented cam design of the "Conquest" allows for the automatic playing of any size of record from 6" dia. to 12" dia. and at speeds of 33⅓, 45 and 78 R.P.M. It will also play the new 16⅔ R.P.M. "Talking Book" records.

• CONSTANT SPEED CHANGE CYCLE ON ALL RECORDS

The change mechanism is driven direct from the motor, giving a constant speed change cycle, irrespective of the type of record being played. The drive to the turntable is thus not involved in driving this mechanism and is not therefore subjected to the comparatively heavy loads imposed during the change cycle. In consequence the accurate driving surfaces of the pulleys are preserved without wear or damage.

• SPRING MOUNTED

The spring mounting of the Record Changer Unit Plate has been designed to ensure that the unit remains level, whatever the number or weight of records being played. Two holes are provided for screws to hold the unit for safe transit. These screws should be removed before the changer is used.

• FREEDOM FROM STALLING

The simplicity of this machine and the patented cam design are both responsible for the elimination of all heavy frictional loads and safely permit the use of a low wattage motor which is comparable with transcription practice.

• MANUAL PLAY

A single record may be played by using the manual control, the pick-up being placed on the record in any desired position. After playing a record in this manner the machine automatically returns the pick-up to its rest and switches off.

• RELIABILITY

This record changer requires a minimum of service, and adjustment should not be necessary. It is recommended that if adjustments are required, due to mishandling or accidental damage, the record changer be returned to your usual retailer or direct to the manufacturer.

• COLOURS

The changer is supplied in any of four colour schemes: All cream finish with maroon turntable mat *OR* all maroon finish with gold unit plate and turntable rim *OR* all maroon finish with cream unit plate and turntable rim *OR* all brown finish with mushroom unit plate and turntable rim. This changer is supplied complete with disc type operating instruction card firmly attached to the spindle.

Sole Australian Agents:

ELECTRONIC INDUSTRIES IMPORTS PTY. LTD.

139-143 Bouverie Street, Carlton. FJ 4161

SYDNEY	ADELAIDE	BRISBANE	PERTH
713 Parramatta Road,	90 Grote Street,	52 Bowen Street,	68 Railway Parade,
Leichhardt, N.S.W. LM 6327	Adelaide. LA 5295-6-7-8	Brisbane. B 6462	West Perth. 28 3111

THE SOURCE OF THE EARTH'S MAGNETISM

(Continued from page 19)

It is easy to fix the system we require ıd, so far, it all works out except for e thing. There has to be some force ıich causes the whirlpools in the liquid ın core. These would not be caused ɪrely by the earth's rotation.

Are we stumped then? Not at all. ience comes up with a remarkable an- er to this one.

For this we travel out to space and ıtch the North Pole for 26,000 years. ientists tell us that if we get out in ace there will be no time, so sitting ere for 26,000 years should present no fficulties.

The reason for this journey is to ıtch what is known as the "precession the equinoxes."

The earth is tilted on its axis 23½ de- ees from the vertical.

But this tilt is not always in the same rection. During the period of 26,000 ars the axis moves around to the other le in a circular motion and back again its original position. It is like the otion of a conical spinning top which ans over and, while spinning, describes circular motion.

Now at first sight, this motion seems ry slow, taking as it does, 26,000 ars to go around, but remembering e size of the earth, it means that the ples are moving around in a circle at e rate of 10 feet per day.

It is this motion, called, as mentioned ove, the "precession of the equinoxes," hich governs the exact time and length day at the spring and autumn equi- oxes.

RESESSIONAL MOTION

It causes the sun to "precede" the esti- ated time when it crosses the plane of e equator at these equinoxes and allow- nces have to be made by astronomers their estimations of the length of day nd year.

This "precessional" motion is brought out by the fact that the earth is flat- ned at the poles and is tilted over. The n and moon are forever trying to ring the axis of the earth to a vertical osition but because of the features ientioned, and the gyroscopic action of ıe earth's spin, the earth resists and given a twisting motion which causes ıe "precession."

Remembering again the size of the arth it must be conceded that the forces equired to do this must be tremen- ous.

So, bringing all features together, we ave something like this—the earth's olten core initially charged with elec- ricity, is swirled around by the pro- igious forces during the "precessional" ıovement of the earth, into the form f whirlpools.

The currents revolve in the whirlpools nd form a series of closed circuits like oils. A magnetic field is generated round these "coils" in accordance with ell-known laws. The lines of force of his field proceed outwards into space nd in doing so are cut by the spinning entral core. This produces more cur- ents in the core again in accordance vith the laws and the system thus is self- ustaining.

Thus it is that science has produced most satisfactory theory to account for errestrial magnetism. Certainly it is nly a theory but a workable one. There may be many questions yet to answer, such as why the earth's metal core does not short circuit all the currents but this is one for the top men to fathom out.

We are told that the earth is gradu- ally cooling off so what will happen to its magnetism at that stage, millions of years hence, we can only conjecture. Perhaps the then solid metal core will become permanently magnetised. We would then have a steady magnetic field, instead of a variable one. Then, just as our scientists have "exploded" the earlier theory of a permanent mag- netic core, scientists of those days will "rediscover" it and pronounce our pres- ent scientists wrong.

EXTRA PERFORMANCE FROM ONE TRANSISTOR

(Continued from Page 53)

socket of the type used for small trans- mitting crystals. These are cheap and take the phone tips very nicely.

In the original model, the headphone socket and eyelets for aerial and earth connections are held by a second piece of punched bakelite mounted on the back of the gang. A wire is soldered to the earth eyelet and another to the particular aerial eyelet required.

Except when the ferrite rod aerial is used, an earth wire is required for the set.

The receiver will operate satisfactorily on any battery delivering between 4.5 and 9 volts. Current drain is between 0.1 and 0.2 mA.

We checked with some data on the very smallest cells obtainable and found that battery life is likely to be over a year if the set is used regularly 7 days per week for 2 hours each day.

Unless you are particularly concerned about size, larger cells will cost very little more and give even better service. By the time you get up to the size of cell used in larger torches (1¼in diam. and 2¼in long) battery life will be so long that it will not much matter whether you switch the set off or not.

Remember that the positive terminal of the battery is connected to the earthy side of the set. Readers who have built valve sets before will find this strange but we can assure you that the set will not work with the battery the other way around and that there is a strong possibility of damaging the transistors with the incorrect connection.

The type of cabinet you choose is largely a matter of personal taste and will depend on how you decide to build the set. If you regard the project as merely an opportunity to become fami- liar with transistors or a stepping stone to a larger set, you may decide to omit the cabinet altogether and simply attach a piece of card behind the knobs to in- dicate frequency.

Readers who like woodworking may care to make a small wooden cabinet or alternatively it is sometimes possible to obtain a suitable small plastic box from one of the chain stores.

We hope to have more to say on the subject of small transistor sets in the near future.

The RADIOMASTER

RADIOGRAM CHASSIS . . .

A great performer on Radio and Records

HI-FI MODEL E22 reproduces perfect high treble notes and bass notes without "drumming" or distortion—brings recorded sound to your home as near as possible to the original. A high gain R.F. stage ensures satis- factory long-distance radio reception. Features include:

Treble and bass boost with separate controls. Two matched Jensen speak- ers (12in and 6in). Eight valves, world range. Push-pull output. Provision for tape recorder. Latest type Radio- tron valves. Custom built. Six months' guarantee. Frequency coverage: 40 to 13,500 cycles. Design tested and ap- proved by the Valve Application Divi- sion of Amalgamated Wireless (A'sia) Ltd.

PRICE £41/15/-

Magic Eye tuning indicator, 30/- extra

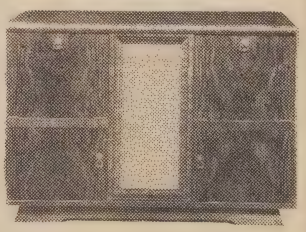
Packing included. Freight extra.

Other Radiomaster Radiogram chassis are available from **£23/15/-**

TELEVISION CHASSIS

21in. models from £125

RADIOGRAM and TV CABINETS



Many popular designs available in- cluding contemporary in natural maple.

New Cabinet Models for Hi-Fi Chassis incorporate vented speaker enclosures. First-class finish.

ALL TYPES OF FOUR-SPEED RADIOGRAM UNITS

WRITE FOR CATALOGUE

H. B. RADIO PRODUCTS

103-105 Catherine Street, Leichhardt, SYDNEY

Telephone LM5580.

VALVE SPECIALS! 50,000 New Valves To Clear

12 for	20/-	1P5, 1Q5, 1L4, 1K5, 1C7, 6H6GT, VR65A, 7193, EF50, 954, 955.
8 for	20/-	6SH7, 6AC7, 7C7, 1J6.
6 for	20/-	6C8G, 12SK7, 12SP7.
4 for	20/-	6U7G, 6J7G, 6SS7, 7C5, 2X2/879, 84, 1T4, 41.
3 for	20/-	EK32/VR57, EL32, 6K8G, 6K7GT, 3S4, 1S5, 1R5, 6AG5.

Post & Packing 4/6 extra

ALL VALVES ARE NEW AND MOSTLY IN INDIVIDUAL CARTONS

FOR THAT C.R.O. or TV SET

POST & PACKING—FRAGILE RATE

NEW 5BP1	37/6	NSW 11/-	INT. 15/-
902	32/6	NSW 5/-	INT. 8/-
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5BP1 CERAMIC SOCKETS 6/6

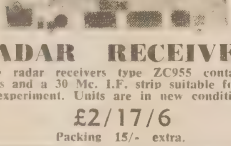
TRANSMITTING VALVES

809	8/6
100 T.H.	8/6
803	25/-

Post Extra

NEW DYNAMIC MICROPHONES
Bakelite hand microphone with switch. 20/. Post 2/6.
Used, but in good condition. 12/6. Post 2/6.
No. 3 CARBON HAND MICROPHONE New. 12/6. Post 2/6.

New American Walkie-Talkie Chassis With 4 piece telescopic AERIAL AND CIRCUIT. Contains basic parts for making small TRANSCEIVER.
CHASSIS TYPE 536/511
22/6. Post 2/6.



RADAR RECEIVERS

These radar receivers type ZC955 contain 16 valves and a 30 Mc. I.F. strip suitable for your TV experiment. Units are in new condition.

£2/17/6
Packing 15/- extra.

COMMAND TRANSMITTERS

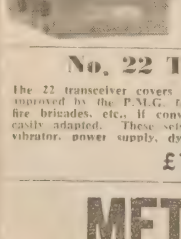
WITH VALVES AND CRYSTAL

55/- F.O.R

4 equals 5.3 Mcs., or 5.3 equals 7 Mcs.

MODULATORS WITH VALVES

25/-
Post extra on Command Equipment.

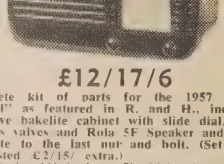


INDICATOR UNITS

These indicator units contain V.R.C. ACR/10 C.R.O. tube and socket. Ideal case for the small scope.
(Used, fair condition.)

30/-
F.O.R.

MAKE UP THE "LITTLE GENERAL"



£12/17/6

Complete kit of parts for the 1957 "Little General" as featured in R. and H., including attractive bakelite cabinet with slide dial. Price includes valves and Rola 5F Speaker and kit is complete to the last nut and bolt. (Set wired and tested £2/15/ extra.)
Cabinet size 11½in long, 7in high, 6in deep.
Foundation Kit for above comprising Bakelite Cabinet, Chassis and Dial Assembly . . 57/6
Post and Packing: N.S.W., 14/6; Interstate, 25/-.

RADIO ALTIMETER APN.1

These units contain valves, midget genemotor (24v) and Wobulator unit used in the R. and H. sweep and marker generator. Also many other useful parts.

£4/17/-
F.O.R.

PILLO-FONE EXTENSION UNIT

IT'S A REAL MINIATURE WITH ROLA UNIT.
Install it anywhere, in the sick room, workshop, garage or any room in the house. Just connect across voice coil of the existing speaker. The 'PILLO-FONE' IS THE MOST CONVENIENT LITTLE UNIT YET DEVISED. 3½in Diameter by 1¾in deep.
POST FREE 22/6

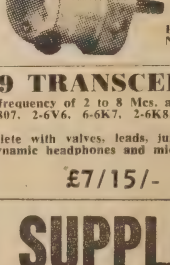
NEW DYNAMIC HEADPHONES

These headphones made by Rola are a high-quality unit giving excellent tone. Fitted with comfortable ear pads.

25/-
Post 4/6.

24 Volt Midget Motors Shunt Wound

Fully Laminated Fields. Wound Armature. Sixteen Segment Commutator, ball bearing. Ideal for Model Trains, Hobbyists, etc. Condition new.



Price, each
25/-
Packing and postage: N.S.W., 1/6; Interstate, 2/6.

No. 22 TRANSCEIVERS

The 22 transceiver covers a frequency of 2 to 8 Mcs., and has been approved by the P.M.G. for use on fishing boats, small craft, bush fire brigades, etc., if converted to crystal control, for which it is easily adapted. These sets are supplied complete with valves, 12v. vibrator, power supply, dynamic headphones and microphone leads.

£12/17/6 F.O.R. PACKAGE 15/- EXTRA.

No. 19 TRANSCEIVERS

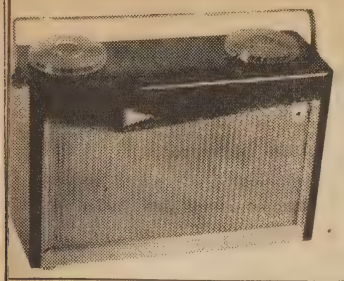
These units cover a frequency of 2 to 8 Mcs. and contain 15 6.3 volt valves, including 1-807, 2-6V6, 6-6K7, 2-6K8, 6B8, etc., also 500 microammeter.
Units supplied complete with valves, leads, junction box, genemotor power supply and dynamic headphones and microphone operate from 12v. supply.

£7/15/-

METROPOLITAN RADIO SUPPLIES

332 PARRAMATTA ROAD, STANMORE, N.S.W.
640 KING STREET, ST. PETERS, N.S.W.

PHONE LM7398
PHONE LA6087



MAKING R. & H. TRANSISTOR PORTABLE ?

COMPLETE KIT OF PARTS

£26/10/-

POST EXTRA

SET WIRED AND TESTED £2 EXTRA

INCLUDING 6 S.T.C. TRANSISTORS, R.C.S. COILKIT WITH PRINTED CIRCUITS, ROLA TRANSFORMERS AND 5F SPEAKER & ALL PARTS NECESSARY TO COMPLETE THIS SET INCLUDING ATTRACTIVE & DURABLE TWO-TONE PLASTIC COVERED CABINET WITH GOLD TRIM.

SPECIAL PURCHASE—HI-FI AT LOW COST

7-VALVE DUAL WAVE HI-FI CHASSIS WITH DUAL SPEAKERS AND LATEST COLLARO 4-SPEED RECORD CHANGER WITH CRYSTAL PICK-UP. THE TWO UNITS

THESE NEW 7-VALVE HI-FI CHASSIS USE THE LATEST PHILIPS 9 PIN VALVES INCLUDING THE DUAL-PURPOSE 6BM8 VALVES IN PUSH-PULL OUTPUT.

WITH EM80 "MAGIC EYE" TUNING INDICATOR, SEPARATE BASS AND TREBLE CONTROLS, ATTRACTIVE PLATEGLASS DIAL AND SUPPLIED WITH JENSEN M.S.P. DUAL SPEAKERS, 12in WOOFER AND 6in TWEETER.

£39/17/6

F.O.R. Packing 10/- extra.

NEW VALVES AT BARGAIN PRICES

1C4	7/6	12K8	10/	6AC7	2/6	6F8G	10/6	7193	3/6
1D4	7/6	12SK7	7/6	6C8G	7/6	6A3	15/	954	2/6
1L4	4/6	EK32	10/6	6S87	8/6	7C7	3/6	955	10/
1T4	10/	6SA7GT	9/6	6H6	2/6	78	7/6	12A6	10/
1S5	10/	6SH7	5/6	6H6GT	1/6	EL32	10/6	EF50	2/6
1S4	10/	1O5G	5/	6K7GT	7/9	15E	7/6	110TH	£2/9/
1R5	12/6	1P5G	5/	6L7G	6/6	6V6GT	12/6	811	£1
1A7GT	9/6	1C7G	5/	6J7G	5/	VR65A	2/6	866/866A	15/
1D8GT	9/6	1K5G	2/6	6J6	15/	41	7/6	12SH7	5/
6A8G	10/6							6K7G	4/6
6K8G	9/6							100TH	20/
6SJ7GT	9/6							1C6	7/6
6X5GT	10/								

Please add Postage on All Valves.
SPECIAL PRICES FOR QUANTITIES

SPARK-PLUG SUPPRESSORS

Kit of 6 plug and distributor suppressors. 10/

AMERICAN TYPE TV TUNING UNITS

These units. 2 vernier dials. 2 transmitter tuning gangs. Ceramic coils, switches, etc. 27/6. F.O.R.

CARBON RESISTORS

New carbon resistors, mixed values. Well-known make.

10/ per 100. Post Free.

NEW I.R.C. RESISTORS

I.R.C. carbon resistors, ½, 1 and 2 watt, in values 50 ohms to 5 meg., including many popular sizes, 3T, 15T, 20T, 25T, 50T, 100T 250T, 500T etc.

(Standard resistor colour code supplied)

100 for 25/-

(Plus 1/6 postage.)

TV I.F. STRIPS

Complete, wired and aligned, supplied with seven miniature valves

Post extra.

£14/10/-

TURRET-TUNERS £15/-/-

I.F. TRANSFORMERS

Standard I.F. transformers square can (1 3/8) 455K.C. permatuned. 4/3.

(Plus Postage.)

New Micro-Ammeters

0-100 micro-amp., 3in flush mounting.

55/-

CONDENSER SPECIALS

Boxes of 100 new Ceramic mica paper and electrolytic condensers in values ranging from 50pf mica to 5 400v paper. Values include .0001, .00025, .00075, .01, .02, .05, .1. Also 500 mfd/12v., 10 mfd/40v., 16 mfd/350v., electrolytics

25/- per 100.

Post Extra: N.S.W. 2/6; Int., 3/6.

MICA CONDENSERS

Standard Mica Condensers, small current types .00003 to .005 including most wanted values.

20/- per 100.

Postage 1/6.

New Power Transformers

260mA prim.: 240v with 230v tapping, Sec. 285 x 285 with 6.3v filament winding. 60mA.

27/6

Plus Postage: N.S.W.; 3/6; INT., 5/3.

New Midget Power Trans.

40mA Prim. 250v Sec. 225 x 225 with 6.3v Fil. Winding. Upright or Flat Mounting. Size 2in x 2½in.

25/-

2/6 Postage. N.S.W.; Interstate, 4/6.

30mA 240v. Prim. 150 x 150v. Sec. with 6.3v Fil. Winding.

22/6

Postage, N.S.W., 2/6; Interstate, 3/6

Please address all correspondence to 332 Parramatta Road, Stanmore, N.S.W.

METROPOLITAN RADIO SUPPLIES

332 PARRAMATTA ROAD, STANMORE, N.S.W. PHONE LM7398

640 KING STREET, ST. PETERS, N.S.W. PHONE LA6087

PEOPLE WHO KNOW . . .

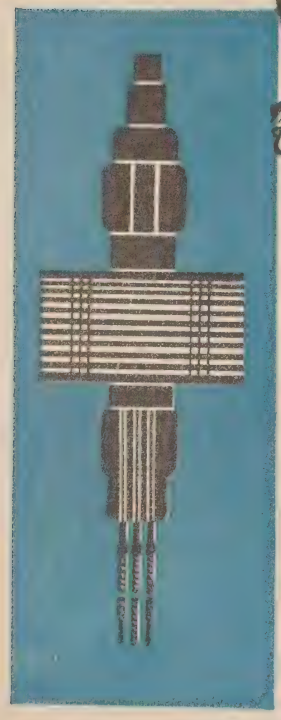
THE PILOT

Ever since Icarus made the first attempt at flight, man has turned his eyes towards the heavens.

Today the sounds of man-made flight are a commonplace thing, and with ever increasing air power has come ever increasing responsibility to the thousands of passengers and air crew members who travel the airways daily.

The responsibility for maintaining strict air schedules and maximum safety during arrivals and departure at the various air terminals throughout the world, is largely handled by means of radio. Without radio many of the safety devices used daily at these air terminals would not exist.

Radio plays a major part in today's air travel, and the Australian valve most used in air to ground communication, is, of course, Radiotron.



RADIOTRON 3786
Used in Aviation
Distance Measuring Equipment.

CHOOSE RADIOTRON

VC8-58

Manufactured by

AMALGAMATED WIRELESS VALVE CO. PTY. LTD.

LET'S BUY AN ARGUMENT

(Continued from Page 99)

rictly limited in its ability to pick gnal voltages directly. Without an rl, the stage would have very little l to amplify.

uch the same would apply to the a and converter input circuits, again use they will have been designed inimise stray coupling and possible bility.

CILLATOR WIRING

n the other hand, no special precau- will have been necessary in rela- to the oscillator wiring, which is lly able to feed signals into the con- r valve and thence into the IF chan-

One might therefore justify the wing conclusions in relation to re- ers with an RF stage:

) Direct signal pickup prior to the grid will be notably small and, in tion to this signal, the RF ampli- will appear to have a very poor sig- o-noise ratio.

2) The converter signal grid may be able to pick up very little signal ctly, though it will have the noise tribution of the RF amplifier im- sed on it, with or without signal.

3) If limited signal is picked up by the oscillator wiring, it will have to compete with the RF stage noise and in any case does not pass through the RF stage.

In a conventional non-RF stage receiver, no special precautions are necessary in relation to layout and shielding and there is a good chance that longer, more exposed aerial, grid and oscillator wiring will pick up more signal than would otherwise be the case.

With more signal available from the wiring and with no carefully shielded RF stage to contribute noise but little signal, the final signal-to-noise ratio may be better.

But, of course, the suggested operating condition is a completely unreal one. Nobody in their right mind would try to use a receiver in a low-signal area without an aerial of some sort attached.

And, as our correspondent says, the moment even a small aerial is attached, the receiver with an RF stage comes good.

Of course, the signal picked up on the aerial, even a small aerial, is far greater than that from stray wiring pickup and, passing through the RF stage, benefits from its better signal-to-noise ratio. That's how I see it, anyway.

MORE ABOUT CHURCH AMPLIFIERS

(Continued from page 79)

Another circuit supplies a small out- or speaker in a weatherproof flare, time through an auto transformer.

With all speakers fully in circuit, the ding on the amplifier would obviously heavier than optimum but experience shown that the need to operate all eakers simultaneously at near-overload lume seldom occurs. In any case, h a tapping on the amplifier second- , there would be the option of con- cting the load across fewer turns, if cessary.

The 16mm. talkie amplifier also hap- ns to have a 15-ohm secondary wind- , which can be jacked into the same eaker circuit, if not fed in other ways rough the main amplifier. Here no eat matching problem exists because ere is no point in feeding "talkie" nd out-of-doors or to adjacent build- gs. These speakers can therefore be itched out of circuit, being used only nen it is desired to relay proceedings the main auditorium via the central nplifier.

In actual fact, to increase flexibility, e two amplifiers are often left connect- across the common speaker lines, ough one important point has to be tched.

Since the amplifiers include negative edback circuits, each tends to resist e efforts of the other to develop volts ross the common load. In other rds, their low output impedance, due feedback, loads the active amplifier ry severely.

It is therefore essential when using a common line to render one amplifier inoperative while the other is delivering output, by turning off its "Standby" switch and thus breaking the HT circuit. This is done automatically in the projector by its normal interlocking switching but the main PA amplifier has to be turned off separately.

HERE'S YOUR ANSWER TOM!

(Continued from page 63)

negative filament pin, where a battery-type valve is involved.

In the case of complete circuits, it is more usual to quote electrode voltages with respect to the chassis, which serves as a common earth return.

I have seen frequent mention made of the damping factor in articles on audio amplifier. What is this damping factor?

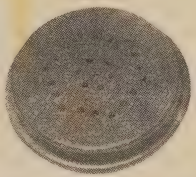
The damping factor of an audio amplifier is the ratio of the load resistance to the effective plate resistance. This damping factor is reflected by the output transformer to the speaker, and affects, in particular, its response to low frequency transients.

Most speakers have some mechanical damping due to their construction and method of housing, but this is often insufficient, and the plate resistance of the output valve, as reflected through the output transformer, acts as an additional shunt damping resistance.

Triodes have a very good damping factor, but tetrodes and pentodes, due to their high plate resistance, have poor damping factors. The application of feedback and use of the ultra-linear connection can reduce their plate resistance, however, to the point where their damping factor is very high.

XMAS Bargain!

CARBON MICROPHONE INSERT



High-grade British unit. Only 1¼in dia. Can be used for telephones; on your radio or amplifier. Full instruction sheet with every insert. This amazing bargain is offered at a fraction of its original cost.

ONLY **2/-** POST FREE

TOYS FOR BOYS

A LARGE RANGE OF LOCAL AND IMPORTED TOYS, INCLUDING HORNBY, TRIANG, DINKY, MATCHBOX, PLASTIC KITS, ETC.

Write for complete price list.

XMAS GIFTS

CRYSTAL SET KIT. "Build it yourself" **42/**

Q-PLUS CRYSTAL SET. With Omega phones and aerial **93/6**

OMEGA PHONES. Ideal for crystal sets **32/6**

RAY-O-VAC Quality Torches.
Standard 2 Cell .. **14/** and **22/5**
Standard 3 Cell **27/6**
Large Head and 2 Cell **28/4**
Large Head and 3 Cell **30/9**
Angle Head and 2 Cell **27/4**
Penlite **12/2**

Large range hand lanterns. Rubber Torches, etc., available.

All torches include batteries.

COLLARO RECORD PLAYER. Latest 4-speed model .. **£12/15/6**

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By referring to a chart up to plus 56db may be measured.
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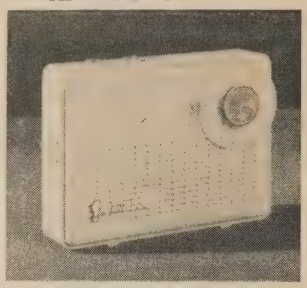

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3. **Twin Rubber covered leads,** with phone plug attached length of lead, 4ft 6in each. **Price only 2/- each.**
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ANSWERS TO CORRESPONDENTS

W. (Katoomba, N.S.W.) has an imported receiver which he would like to have align- and also, if possible, obtain a circuit and as ion information as possible about it.

Q. We regret we cannot help very much B.W. A are not familiar with the set, and suggest that local branch of the company might be able to e or that it would be worth while writing to makers overseas. We are not familiar with controls, but we imagine that the one which es the tone is, in fact, a tone control. We described some noise reducing aerials in issues and copies of these are available ugh our query service. It is normal prac- to earth all receivers, even though the effect ot very noticeable in most cases. If nothing it provides normal protection for the opera- in the event of component breakdown.

.S. (Toora, Vic.) writes in to say that he has pleted a push-pull amplifier using two 6V6's. wishes to measure its power output using AC-DC multimeter and wishes to know how to about doing this.

Q. To measure the power output of your amplifi- G.S., it will be necessary to provide a source signal to feed the amplifier, a load resistor hav- the same resistance as the nominal impedance he voice coil and a meter to read the voltage eloped across this resistor. A C.R.O. is also essary to give an indication of the overload nt. The signal source has to be such as to the amplifier fully. The output measurement be made at one frequency generally at 1KC. meter should be set to an AC volts range and nected across the load resistor, which is in connected across the secondary of the out- transformer. The input to the amplifier should adjusted to give a clean sine wave, without erload on the screen of the C.R.O., which is connected across the load resistor. The volt- reading thus obtained may be used to com- e the power output in watts. To do this, the tage figure should be squared and result divided the load resistance value. The figure thus ained is the output in watts.

S.A.M. (Maffra, Vic.) has made the Standard CRO which was described in the March, 1950 ue of Radio, Television and Hobbies. A care- construction check will reveal the wiring l voltages has failed to reveal anything wrong he is still unable to make the instrument erate.

A. Our records show that there have been no ors in the circuit for this instrument reported if all components and wiring are in order we not see any reason why it should not work. not mention that you have tried another diode-ray tube, and if this is the one item which been common to all your experiments we sug- that you try to borrow another 902 or R139A for trial. Voltages appearing on the O cannot easily be measured without a high re- ance VTVM. The total supply voltage for the e in this instrument is about 700 volts. We not have a breakdown of the various electrode tages but the following data will give you an a of the general order of voltages and currents.

CRO TUBE TYPE VCR 139A

The VCR139A is a 2¾in tube with a 4 volt 1.1 mp heater. Main anode voltage (1st anode) 2,000 lts max. Second anode 120/175 volts, third ode as for first anode. Normal working voltage 1st anode 800 volts; 2nd anode 120/175 volts; rd anode 800 volts. Beam current up to 150 . Grid voltage — 0 volts. Cut-off bias —12 lts. Base connections: Pin 1 cathode, pin 2 grid, n 3 and 4 heater, pin 5 anode 2, pin 6 blank, n 7 Y2, pin 8 X2, pin 9 anodes 1, 3 and 4, pin X1, pin 11 Y1, pin 12 blank.

S.J.R. (Caulfield, Vic.) wants to know if it is ssible to connect a TV tuner to an FM set in der to hear the sound channel from the TV tions. He also wants to know whether we have er described an FM set to do the same job.

A. It would not be feasible to connect the tuner the manner you suggest S.J.R., in view of the ite different intermediate frequencies used for se units. We have not described any FM sets ecifically to receive TV sound, but most such ners are capable of receiving Channel 2. Recep- n of the higher channels is not so simple.

A.N. (Cessnock, N.S.W.) would like to know e price of the transistor portable receiver ich appeared on the cover recently.

A. We regret that we do not have any in- rmation which would be of assistance to you be- se the receivers would not normally be import- to this country. The picture was published as matter of general interest only. Perhaps the xt year or two will see receivers of this type de in Australian factories.

A.N.D. (Kew, V.) writes to tell us of his ex- iences with one of the 12in disposals tubes in TV set, and also to describe some of the cir- ts he has used in the set. He is particularly ppy with the brilliance obtained from a 63DS e running on only 1,200 volts EHT.

A. Many thanks for your letter and comments A.N.D., and we are glad to learn that you are obtaining such excellent results. However, we feel that you must have been particularly fortunate in obtaining such a tube, since none of those we have been able to test — and we have tested a good many — have been able to achieve anything like this performance. Other readers have reported similar results. In the circumstances we suggest you cherish your present tube, because it is unlikely that you will obtain another like it. It is quite true, of course, that any tube needs to be adequately modulated, but extreme modulation is no substitute for brilliance. If the tube has limited brilliance it simply will not respond to the modulation. Quite naturally, with only 1,200 volts EHT, deflection becomes a good deal easier, but we would repeat that those tubes requiring up to 4,000 volts — and this would appear to be most of them — will present a number of deflection problems if the full size of the screen is to be utilised. We have noted your deflection system briefly, and this appears to be quite ingenious. However, it would probably not be adequate for higher voltage conditions.

C.W.W. (Box Hill, Vic.) wants to know if any manufacturers are supplying booster transformers to increase the heater voltage of picture tubes approaching their end of life.

A. As far as we know, no such transformers have made their appearance yet in quantity, though we have seen experimental prototypes. The point is there has not been sufficient time to create a demand. On this same theme, we feel that you may be unduly pessimistic concerning your own tube which, by the law of averages, should have at least as much life in it as you have already obtained.

R.G.T. (Geelong, Vic.) enquires about apparent defect in some of his LP records. He also suggests we consider describing a smaller TV set now that a few 14in tubes are available.

A. From your description we feel that the defect is what is sometimes referred to as "swishing"; an effect apparently due to a segment of the record material having characteristics different from the remainder. Records which showed this defect, even slightly, usually deteriorated more rapidly in this section, eventually becoming quite objectionable. It is a trouble which appears to have been largely overcome and is seldom encountered with modern records. We are considering the 14in tubes, but the exact position regarding the home builder is not clear at the moment. When it is — and we have time — we will certainly pursue this idea.

P.O.'s Shepparton, (Vic.) says he has just started out in radio and is worried because he cannot obtain a 350 pf reaction condenser.

A. The circuit you are following must be a very old one because it has been the practice for years to use nothing larger than about 100pf for reaction control. Actually, there is nothing special about a reaction capacitor and you could easily use an ordinary tuning capacitor in the circuit. Removing plates, as your dealer has suggested, would reduce the value and make the adjustment a little less critical but you would run the risk of damaging the unit.

K.A. (Burwood, N.S.W.) says that he bought an item of disposals equipment (SC3540A) and would like to obtain some technical information about it.

A. We cannot help, but some reader may be able to do so. (K. Andrews, 1 Clarence Street, Burwood, N.S.W.).

T.P. (Lalbert, Vic.) wants to know where he can obtain details of a rhombic aerial to suit the Melbourne TV stations.

A. The ARRL Antenna Handbook should be available from the larger bookstalls in Melbourne, such as the Technical Book and Magazine Co., 295 Swanston Street, Melbourne. We would also refer you to "Basic Television" by Grob, which also covers this subject. If either of these books is unavailable for purchase, or too expensive, you should still be able to refer to them at your nearest large public library.

A.W. (Liverpool, N.S.W.) asks if the heaters of heater cathode type valves are normally connected in parallel.

A. Yes, A.W., this is the more usual connection but it is not necessarily the case. Sometimes the designer has a set of 6.3 volt valves available and wishes to operate them from a 12-volt transformer winding or a 12 volt accumulator. A series/parallel heater string is then used, sometimes with a resistor or resistors in order to equalise current and make sure that valves at both ends of the network have the same voltage applied.

B.H.D. (Raleigh, N.S.W.) sends us an extract from a women's magazine concerning the activities of a husband who tried to build a "super-colossal" type of receiver without much success. He also encloses a story for the serviceman and a request for an "Economy" type of amplifier along the lines of the "Economy" receivers recently described.

A. Many thanks for the story B.H.D., and we can only comment that it obviously could not have been one of our designs, since no R.T. and H. set would ever behave like that. Thanks also for the Serviceman story, which we will pass on to him for his possible comment. We will consider the idea of an "Economy" amplifier, although the range of valves available through disposals is less suited to this than to straight out receivers. The nearest we have described so far would be the Basic Amplifier of April, 1956. This was designed to use the widest possible range of parts.

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Queries not accompanied by the necessary fee will be answered FREE in the columns of the magazine and presented in such a way as to be of interest to other readers.

To those requiring only circuit reprints, &c., we will supply for TWO SHILLINGS diagrams and parts lists from our files covering up to three constructional projects. Scale blueprints showing the position of all holes and cutouts in standard chassis can be supplied for 5/-. These are available for nearly all our designs but please note they do NOT show wiring details.

Address your letters to The Technical Editor, RADIO, TELEVISION and HOBBIES, Box 2728C, GPO, Sydney.

Note that we do not deal in radio components. Price quotations and details of merchandise must be obtained direct from our advertisers.

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Merry Christmas

and a

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AMPLIFIER RESPONSE AND STABILITY

(Continued from page 41)

compensation circuits that do not
ct the response for some distance be-
d the usable frequency range must
preferred, not only because of their
sible superiority in frequency response
low distortion, but in the interests
achieving the highest standard of
ility.

s promised in an earlier issue, we
including with this article a layout
a component strip which may be wir-
up as a unit, and which supports
rly all resistors and capacitors.

he strip is mounted on two long
in bolts which run through the top
he chassis.

nderneath the strip, and therefore
snown, are leads connecting to-
her three high tension and three earth
nts.

he high tension lead is connected to
ig at the extreme right-hand end of
p, continues across to the end of the
decoupling resistor, and thence to
ig at the extreme right hand end of
strip where it makes a convenient
nt to connect the centre tap of the
put transformer primary.

he earth lead is connected to the end
the 100 ohm resistor in the EF86
ode, thence to the earthed end of the
resistor in the cathode circuit of the
X7, and finally to the earthy end of
8K grid resistor for the EL37.

hese hidden leads are connected to
lugs by soldering through the eyelet
es.

he whole strip may be pre-assembled,
then wired into place.

he feedback resistor and capacitor
wired to pins on the four-pin socket
d for loud speaker connection.

his lead is earthed to the chassis at
y one point, near the EF86 valve, to
ich point is earthed the EF86 grid
stor and the earthed connections from
control unit.

he grid coupling capacitors for the
37s are not drawn in the diagram, but
ir connecting points are clearly indi-
ed by small numbered arrows. One
them is tucked under the strip, but
other can be seen in the photograph.

he capacitor which earths one-grid
the 12AX7 is also tucked under the
p and is earthed to the appropriate
l of the 22K resistor in the cathode
cuit of this valve.

he strip is connected to the valve
kets by short, direct leads.

MPROVEMENTS TO VTVM

(Continued from Page 70)

tors originally used in the input divider
work, meaning that the DC ranges
l be out by a like amount.

Such drift is not unusual in all but
most precise resistors, but it is also
e that most resistors settle down after
ew years and become quite stable. For
s reason it is better to add shunt or
ies resistors to these, than to discard
m in favour of new ones.

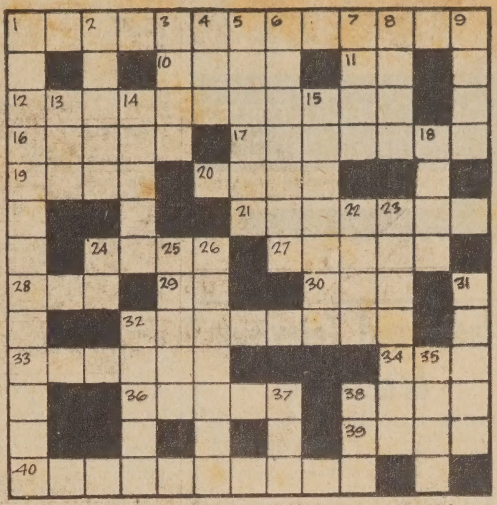
Resistors usually drift high, so it is
to fit shunt resistors to bring them
to ...rmal. This is usually most
...chanic...anyway, and it
...ry half
...he total
...ll effect
... in the
total resistance, quite substantial drift on the part of the shunt is of little consequence.)

Because of the voltage divider arrangement the adjustment of any one resistor will effect all ranges, though it can do nothing but good if it is being brought back to its original value. In estimating which resistors need to be changed, try to work out which resistor would have to "go high" to bring about the direction of error observed.

Also be careful to take into account the errors on all ranges, and to check the effect on all ranges of any corrections that are made. Fairly obviously, changes made to the lower value resistors will have little effect on these ranges provided by the higher values, so that it is best to correct the higher resistance values first.

This should be the final step in bringing your old instrument up to date, and ready for many more years of faithful service. We feel sure you will agree with us that the small amount of effort and expenditure has been well worth while.

THE R., T.V. & H. CROSSWORD No. 56



ACROSS

1. Force which produces magnetic flux density.
10. Fail, fade.
11. Prefix meaning apart from
12. Resonant transmission lines.
16. In films, separate samples of the same shot.
17. Warned.
19. Metallic element.
20. Coarse part of meal.
21. Russian River.
24. Organs of sight.
27. Colour.
28. Enclosed place for corn.
29. Belonging to me.
30. Name given to a piece of pipe used to connect two pipes at right angles.
32. Horizontal axis.
33. Something worn to prevent evil.
34. Aeriform elastic fluid
36. Girl's name.
38. Legal charge upon property.
39. 4,840 sq. yards.
40. Shows effect of radioactive waves.

DOWN

1. Arrangement of valves generating relaxation oscillations.
2. A type of lizard.
3. Female sheep (pl.)
4. Thick, resinous substance
5. Internal.
6. Interior part of the roof of a room.
7. Across.
8. To repose.
9. Exclamation used as a minced oath.
13. Organ of hearing.
14. Man's name.
15. Withdraws from action
18. Smooth.
22. Snake-like fishes.
23. Pertaining the deep sea.
24. Prefix meaning in.
25. Smouldering cinder.
26. Regular method or order (pl.)
31. Middle.
32. Plea of of having been elsewhere.
35. Prefix meaning air.
37. Self.
38. Town in New Guinea.

Solution and further crossword next month

Last month's solution

F	R	I	N	G	E	A	R	E	A	■	■	A
O	■	M	■	R	■	■	■	Q	■	E	R	R
O	S	P	R	E	Y	■	B	U	S	B	A	R
T	E	E	■	Y	■	N	■	I	■	O	N	E
L	I	D	■	■	K	E	L	V	I	N	■	S
A	N	A	G	R	A	M	■	A	■	I	■	T
M	E	N	■	■	R	E	A	L	I	T	Y	■
B	■	C	■	P	O	S	S	E	■	E	■	R
E	V	E	■	A	L	I	■	N	■	■	■	E
R	■	■	O	P	U	S	■	T	A	P	E	S
T	R	A	C	E	S	■	L	■	■	I	■	I
■	■	S	T	R	■	C	O	S	I	N	E	S
■	C	H	O	S	E	■	W	■	■	T	■	T

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